This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE FIRST SESSION OF THE FIFTIETH CONGRESS.

IN FOUR VOLUMES.

VOLUME II.
PART 2.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

CONTENTS.

[Alphabetical Index will be found at the end of each Part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS 3

SEA-COAST AND LAKE FRONTIER DEFENSES.

GENERAL DISCUSSION 4

ESTIMATES OF APPROPRIATIONS FOR 1888-'89 5

THE BOARD OF ENGINEERS.

Officers constituting Board, Fortifications, 5; *Subjects considered and reported upon*, 5; *Sea-coast fortifications, Torpedo defense*, 8.

POST OF WILLETS POINT, ENGINEER SCHOOL OF APPLICATION, BATTALION OF ENGINEERS, AND ENGINEER DEPOT AT WILLETS POINT, NEW YORK HARBOR 12

RIVER AND HARBOR IMPROVEMENTS.

GENERAL STATEMENT 13

ATLANTIC COAST AND GULF OF MEXICO.

IN CHARGE OF MAJ. JARED A. SMITH, CORPS OF ENGINEERS—

Lubec Channel, Me., 14; Moose-a-bec Bar, Me., Narraguagus River, Me., 15; Bangor Harbor and Penobscot River, Me., Belfast Harbor, Me., 16; Rockland Harbor, Me., Portland Harbor, Me., 17; channel in Back Cove, Portland, Me., breakwater at mouth of Saco River, Me., 18; Saco River, Me., Kennebunk River, Me., York Harbor, Me., 19; Portsmouth Harbor, N. H., Cocheco River, N. H., 20; harbor of refuge at Little Harbor, N. H., examinations and surveys, 21.

IN CHARGE OF LIEUT. COL. GEORGE L. GILLESPIE, CORPS OF ENGINEERS—

Newburyport Harbor, Mass., 22; Merrimac River, Mass., 23; Ipswich River, Mass., harbor of refuge, Sandy Bay, Cape Ann, Mass., 24; Gloucester Harbor, Mass., Lynn Harbor, Mass., 25; Boston Harbor, Mass., 26; Malden River, Mass., Hingham Harbor, Mass., 28; Scituate Harbor, Mass., 29; Plymouth Harbor, Mass., Provincetown Harbor, Mass., 30.

IN CHARGE OF MAJ. WILLIAM R. LIVERMORE, CORPS OF ENGINEERS—

Harbor of refuge at Hyannis, Mass., 31; harbor of refuge at Nantucket, Mass., 32; Wood's Holl Harbor, Mass., 33; Wareham Harbor, Mass., 34; Westport Harbor, Mass., Taunton River, Mass., 35; Warren River, R. I., Pawtucket River, R. I., 36; Providence River and Narragansett Bay, R. I., 37; removal of Green Jacket Shoal, Providence River, R. I., Newport Harbor, R. I., 38; harbor of refuge at Block Island, R. I., 40; Little Narragansett Bay, R. I. and Conn., harbor of refuge at Stonington, Conn., 41; Pawcatuck River, R. I. and Conn., 42; examinations and surveys, 43.

IN CHARGE OF LIEUT. COL. D. C. HOUSTON, CORPS OF ENGINEERS—

Thames River, Conn., 43; New London Harbor, Conn., Connecticut River, Mass. and Conn , 44; Clinton Harbor, Conn., New Haven Harbor, Conn., 46; breakwater at New Haven, Conn., 47; Milford Harbor, Conn., Housatonic River, Conn., 48; Bridgeport Harbor, Conn., Black Rock Harbor, Conn., 49; Southport Harbor, Conn., Norwalk Harbor, Conn., 50; Stamford Harbor, Conn., Port Chester Harbor, N. Y., 51; Mamaroneck Harbor, N. Y., Echo Harbor, New Rochelle, N. Y., 52; New Rochelle Harbor, N. Y., East Chester Creek, N. Y., 53; Greenport Harbor, N. Y., Port Jefferson Harbor, N. Y., 54; Flushing Bay, N. Y., removing sunken vessels or craft obstructing or endangering navigation, examinations, 55.

IN CHARGE OF LIEUT. COL. W. MCFARLAND, CORPS OF ENGINEERS—

Hudson River, N. Y., 56; harbor of Saugerties, N. Y., harbor at Rondout, N. Y., 57; Harlem River, N. Y., 58; removing obstructions in the East River and at Hell Gate, N. Y., 59; Newtown Creek, N. Y., Buttermilk Channel, N. Y., 60; Gowanus Bay, N. Y., 61; New York Harbor, 62; Sheepshead Bay, N. Y., Canarsie Bay, N. Y., 64; Sumpawanus Inlet, N. Y., Channel between Staten Island and N. J., 65; Raritan Bay, N. J., 66; examinations, 67.

IN CHARGE OF LIEUT. GEORGE MCC. DERBY, CORPS OF ENGINEERS—

Passaic River, N. J., 68; Elizabeth River, N. J., 69; Rahway River, N. J., 70; Woodbridge Creek, N. J., Raritan River, N. J., 71; South River, N. J., 72; Cheesequakes Creek, N. J., Keyport Harbor, N. J., 73; Mattawan Creek, N. J., Shrewsbury River, N. J., 74; Manasquan River, N. J., 75.

IN CHARGE OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS—

Delaware River, Pa. and N. J., 76; Frankford Creek, Pa., Schuylkill River, Pa., 78; ice-harbor at Marcus Hook, Pa., 79; ice-harbor at the head of Delaware Bay, Del., construction of iron pier in Delaware Bay, near Lewes, Del., 80; harbor at Delaware Breakwater, Del., 81; Rancocas River, N. J., Woodbury Creek, N. J., 82; Mantua Creek, N. J., Raccoon River, N. J., 83; Salem River, N. J., Cohansey Creek, N. J., 84; removal of wrecks from Delaware Bay and River, removing sunken vessels or craft obstructing or endangering navigation, survey for harbor at Atlantic City, N. J., United States commission advisory to the board of harbor commissioners of Philadelphia, Pa., 85; examinations, 86.

IN CHARGE OF MR. WILLIAM F. SMITH, U. S. AGENT—

Maurice River, N. J., 86; Wilmington Harbor, Del., 87; ice-harbor at New Castle, Del., 88; Duck Creek, Del., St. Jones River, Del., 89; Mispillion Creek, Del., Broadklin River, Del., 90; Indian River, Del., inland water-way from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 91; Susquehanna River above and below Havre de Grace, Md., 92; Chester River at Kent Island Narrows, Md., Corsica Creek, Md., 93; Choptank River, Md., Nanticoke River, Del., 94; Broad Creek, Del., from its mouth to Laurel, Wicomico River, Md., 95; Upper Thoroughfare between Deil's Island and the mainland, Pocomoke River, Md., removing sunken vessels or craft obstructing or endangering navigation, 96; examination and surveys, 97.

IN CHARGE OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS—

Patapsco River and channel to Baltimore, Md., 97; Annapolis Harbor, Md., 98; rebuilding piers at Battery Island, head of the Chesapeake Bay, 99; James River, Va., 100; removing sunken vessels or craft obstructing or endangering navigation, 101; examination, 101.

IN CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS—

Harbors at Washington and Georgetown, D. C., 101; Potomac River at Washington, D. C., 102; reconstruction of Aqueduct Bridge, D. C., 104; bridge across the Eastern Branch of the Potomac River, D. C., Shenandoah River, West Va., 105.

IN CHARGE OF MR. S. T. ABERT, U. S. AGENT—

Channel at Mount Vernon, Va., Neabsco Creek, Va., 106; Breton Bay, Leonardtown, Md., Nomini Creek, Va., 107; harbor at entrance of St. Jerome's Creek, Md., Rappahannock River, Va., 108; Totusky River, Va., Urbana Creek, Va., Mattaponi River, Va., 109; Pamunkey River, Va., York River, Va., 110; Chickahominy River, Va., Staunton River, Va., 111; Dan River, between Madison, N. C., and Danville, Va., Roanoke River, N. C., 112; French Broad River, N. C., 113; examinations and surveys, 114.

In charge of Capt. F. A. Hinman, Corps of Engineers—

Harbor at Norfolk, Va., 114; approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Va., 115; Archer's Hope River, Va., Appomattox River, Va., 117; North Landing River, Va. and N. C., Currituck Sound, Coanjok Bay, and North River Bar, N. C., 119; Blackwater River, Va., 120; Nottoway River, Va., Meherrin River, N. C., 121; Edenton Bay, N. C., 122; removing sunken vessels or craft obstructing or endangering navigation, 123; examinations and survey, 123.

In charge of Capt. W. H. Bixby, Corps of Engineers—

Pamlico and Tar Rivers, N. C., 123; Contentnia Creek, N. C., 124; Trent River, N. C., 125; Neuse River, N. C., 126; inland water-way between New Berne and Beaufort, N. C., 127; harbor at Beaufort, N. C., 128; inland water-way between Beaufort Harbor and New River, N. C., through Bogue Sound, New River, N. C., 129; Black River, N. C., 130; Cape Fear River, N. C., 131; Yadkin River, N. C., 133; Waccemaw River, S. C., 134; Great Pee Dee River, S. C., harbor at Georgetown, S. C., 135; Winyaw Bay, S. C., Santee River, S. C., 136; Wateree River, S. C., 137; Congaree River, S. C., 138; removing sunken vessels or craft obstructing or endangering navigation, 139; examinations and surveys, 139.

In charge of Col. Q. A. Gillmore, Corps of Engineers—

Charleston Harbor, S. C., 140; Wapoo Cut, S. C., 141; Ashley River, S. C., 142; Edisto River, S. C., 143; Salkahatchie River, S. C., 144; Savannah Harbor and River, Ga., 145; Savannah River, Ga., 146; Savannah River, above Augusta, Ga., St. Augustine Creek (Thunderbolt River), Ga., Romerly Marsh, Ga., 148; Altamaha River, Ga., 149; Doboy Bar, Ga., 150; Brunswick Harbor, Ga., 151; entrance to Cumberland Sound, Ga. and Fla., 152; inside passage between Fernandina and St. John's River, Fla., 153; examination, 154.

In charge of Capt. William M. Black, Corps of Engineers—

Saint John's River, Fla., 154; Volusia Bar, Fla., 155; Upper Saint John's River, Fla., survey of entrance to harbor of Key West, Fla., 156; Caloosahatchie River, Fla., 157; Pease River, Fla., Manatee River, Fla., 158; Tampa Bay, Fla., 159; Withlacoochee River, Fla., 160; harbor at Cedar Keys, Fla., Suwanee River, Fla., 161; removing sunken vessels or craft obstructing or endangering navigation, 162; examinations, 162.

In charge of Capt. R. L. Hoxie, Corps of Engineers—

Apalachicola River, Fla., 162; Apalachicola Bay, Fla., 163; La Grange Bayou, Fla., Pensacola Harbor, Fla., 164; Choctawhatchee River, Fla. and Ala., Escambia and Conecuh rivers, Fla. and Ala., 165; Oconee River, Ga., 166; Ocmulgee River, Ga., Oostenaula and Coosawattee rivers, Ga., Flint River, Ga., 167; Coosa River, Ga. and Ala., 168; Chattahoochee River, Ga. and Ala., Tallapoosa River, Ala., 169; Cahawba River, Ala., Alabama River, Ala., 170; examination, 171.

In charge of Maj. A. N. Damrell, Corps of Engineers—

Mobile Harbor, Ala., 171; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., Warrior River, Ala., 172; Tombigbee River, from Fulton to Vienna, 173; Tombigbee River, below Vienna, Old Town Creek, Miss., 174; Noxubee River, Miss., Pascagoula River, Miss., 175; harbor at Biloxi Bay, Miss., Pearl River, Miss., between Edinburgh and Carthage, 176; Pearl River, Miss., from Jackson to Carthage, Pearl River, Miss., below Jackson, 177; examination, 178.

In charge of Maj. W. H. Heuer, Corps of Engineers—

Inspection of the improvement at the South Pass of the Mississippi River, 178; Tchefuncte River and Bogue Falia, La., 179; Tangipahoa River, La., 180; Tickfaw River, La., Amite River, La., 181; Bayou La Fourche, La., Bayou Terrebonne, La., 182; Bayou Black, La., Bayou Teche, La., 183; connecting Bayou Teche with Grand Lake at Charenton, La., Bayou Courtableau, La., 184; Calcasieu River and Pass, La., Bayou Pierre, Miss., 185; Sabine River, La. and Tex., Neches River, Tex., 186; Sabine Pass, Tex., 187; removal of sunken vessels or craft obstructing or endangering navigation, 188; examinations and survey, 188.

In charge of Maj. O. H. Ernst, Corps of Engineers—

Entrance to Galveston Harbor, Tex., ship-channel in Galveston Bay, Tex., Trinity River, Tex., 189; Buffalo Bayou, Tex., 190; Mouth of Brazos River, Tex., Pass Cavallo Inlet to Matagorda Bay, Tex., Aransas Pass and Bay, up to Rockport and Corpus Christi, Tex., 191; harbor at Brazos Santiago, Tex., protection of river-bank at Fort Brown, Tex., 192; examination, 193.

WESTERN RIVERS.

In charge of Capt. J. H. Willard, Corps of Engineers—

Red River, La. and Ark., 193; Cane River La., survey of Bayou Pierre, La., Cypress Bayou, Tex. and La., 194; Loggy Bayou, Lake Bistenau, and the Dorcheat, La., Ouachita and Black Rivers, Ark., and La., Bayou D'Arbonne, La., 195; Bayou Bartholomew, La. and Ark. Bayou Boeuf, La., 196; Tensas River and Bayou Macon, La., 197; Big Black River, Miss., Yazoo River, Miss., 198; Tchula Lake, Miss., Yallabusha River, Miss., 199; Tallahatchee River, Miss., Steele's Bayou, Miss., Big Sunflower River, Miss., 200; Big Hatchie River, Tenn., 201; South Forked Deer River, Tenn., water-gauges on the Mississippi River and its principal tributaries, 202; examinations, 203.

In charge of Capt. H. S. Taber, Corps of Engineers—

Red River, above Fulton, Ark., 203; Little Red River, Ark., Saline River, Ark., removing obstructions in Arkansas River, Ark., 204; Arkansas River, Ark., 205; survey of Arkansas River, Ark., from Little Rock to its mouth, Petit Jean River, Ark., 206; Fourche River, Ark., White River, Ark., 207; Black River, Ark. and Mo., 208; Saint Francis River, Ark., L'Anguille River, Ark., 209; examinations, 210.

In charge of Maj. A. M. Miller, Corps of Engineers—

Removing snags and wrecks from the Mississippi and Missouri rivers, 210; Mississippi River between the Ohio and Illinois rivers, 211; Gasconade River, Mo., Osage River, Mo. and Kans., 214; examination, 215.

In charge of Capt. Clinton B. Sears, Corps of Engineers—

Missouri River from Sioux City, Iowa, to Fort Benton, Mont., 215; Yellowstone River, Mont. and Dak., 216; examination, 217.

In charge of Capt. E. H. Ruffner, Corps of Engineers—

Mississippi River between the Des Moines Rapids and the mouth of the Illinois River, 217; examination, 218.

In charge of Maj. A. Mackenzie, Corps of Engineers—

Upper Mississippi River, operations of snag-boats and dredge-boats, etc., Mississippi River, from Des Moines Rapids to mouth of the Illinois River, 218; Mississippi River, from Saint Paul to Des Moines Rapids, Des Moines Rapids Mississippi River, 219; operating and care of Des Moines Rapids Canal, 220; dry dock at Des Moines Rapids Canal, removal of bar in Mississippi River opposite Dubuque, Iowa, 221; ice-harbor at Dubuque, Iowa, harbors of refuge on Lake Pepin, at Lake City, Minn., 222; harbors of refuge on Lake Pepin, at Stockholm, Wis., 223.

In charge of Maj. Charles J. Allen, Corps of Engineers—

Preservation of the Falls of St. Anthony, Minn., construction of lock and dam on the Mississippi River at Meeker's Island, Minn., 223; Mississippi River above the Falls of St. Anthony, Minn., reservoirs at headwaters of the Mississippi River, 224; Chippewa River, Wis., 225; Chippewa River at Yellow Banks, Wis., 226; St. Croix River below Taylor's Falls, Minn. and Wis., Minnesota River, Minn., 227; Red River of the North, Minn. and Dak., 228; construction of lock and dam at Goose Rapids, Red River of the North, Minn. and Dak., 229; examinations, 229.

In charge of Lieut. Col. J. W. Barlow, Corps of Engineers—

Tennessee River, 230; French Broad River, Tenn., 231; Little Tennessee River, Tenn., Hiawassee River, Tenn., 232; Clinch River, Tenn., Duck River, Tenn., Cumberland River, Tenn. and Ky., 233; South Fork of Cumberland River, Ky., Caney Fork River, Tenn., 235; examinations, 236.

IN CHARGE OF LIEUT. COL. WM. E. MERRILL, CORPS OF ENGINEERS—

Ohio River, 236; operating and care of Davis Island Dam, Ohio River, Monongahela River, W. Va. and Pa., 238; operating and care of lock and dam No. 9, Monongahela River, Allegheny River, Pa., dam at Herr's Island, Allegheny River, 239; ice-harbor at mouth of Muskingum River, Ohio, operating and care of the locks and dams on the Muskingum River, Ohio, 240; harbor of refuge near Cincinnati, Ohio, harbor of refuge at mouth of Great Kanawha River, W. Va., Big Sandy River, W. Va. and Ky., 241; Guyandotte River, W. Va., Little Kanawha River, W. Va., 242; Buckhannon River, W. Va., 243; examinations, 243.

IN CHARGE OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS—

Falls of the Ohio, Louisville, Ky., 244; Indiana Chute, Falls of the Ohio River, operating and care of the Louisville and Portland Canal, 245; Wabash River, Ind. and Ill., 246; White River, Ind., Kentucky River, Ky., 247; operating and keeping in repair locks and dams on the Kentucky River, Ky., improvement of Tradewater River, Ky., 248; examinations, 249.

IN CHARGE OF LIEUT. COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS—

Great Kanawha River, W. Va., 249; Elk River, W. Va., New River from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 251; examinations, 253.

LAKE HARBORS AND RIVERS.

IN CHARGE OF CAPT. JAMES B. QUINN, CORPS OF ENGINEERS—

Harbor at Duluth, Minn., 253; harbor at Superior Bay and St. Louis Bay, Wis., 254; harbor at Agate Bay, Minn., harbor at Grand Marais, Minn., 255.

IN CHARGE OF CAPT. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS—

Ashland Harbor, Wis., Ontonagon Harbor, Mich., 256; Eagle Harbor, Mich., establishment and maintenance of harbor-lines in Portage Lake, Mich., Marquette Harbor, Mich., 257; harbor of refuge, Grand Marais, Mich., 258; Manistique Harbor, Mich., Cedar River Harbor, Mich., 259; Menomonee Harbor, Mich. and Wis., Oconto Harbor, Wis., 260; Pensaukee Harbor, Wis., Green Bay Harbor, Wis., 261; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., Ahnapee Harbor, Wis., 262; Kewaunee Harbor, Wis., Two Rivers Harbor, Wis., 263; Manitowoc Harbor, Wis., 264; Sheboygan Harbor, Wis., Port Washington Harbor, Wis., 265; examination, 266.

IN CHARGE OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS—

Harbor of refuge, Milwaukee Bay, Wis., 266; Milwaukee Harbor, Wis., 267; Racine Harbor, Wis., Kenosha Harbor, Wis., 268; Waukegan Harbor, Ill., 269; Fox and Wisconsin rivers, Wis., 270.

IN CHARGE OF MAJ. THOS. H. HANDBURY, CORPS OF ENGINEERS—

Chicago Harbor, Ill., 272; Calumet Harbor, Ill., 273; Illinois River, Ill., 274; Calumet River, Ill. and Ind., 275; surveys for Hennepin Canal, 276; examinations and survey, 277.

IN CHARGE OF CAPT. D. W. LOCKWOOD, CORPS OF ENGINEERS—

Charlevoix Harbor and entrance to Pine Lake, Mich., 277; Frankfort Harbor, Mich., harbor of refuge at Portage Lake, Mich., 278; Manistee Harbor, Mich., Ludington Harbor, Mich., 279; Pentwater Harbor, Mich., White River Harbor, Mich., 280; Muskegon Harbor, Mich., Grand Haven Harbor, Mich., 281; Grand River, Mich., Black Lake Harbor, Mich., 282; Saugatuck Harbor, Mich., South Haven Harbor, Mich., 283; Saint Joseph Harbor, Mich., Michigan City Harbor, Ind., 284; examinations, 286.

In charge of Lieut. Col. O. M. Poe, Corps of Engineers—

St. Mary's Falls Canal and River, Mich., 286; operating and care of St. Mary's Falls Canal, Mich., Dry-dock at St. Mary's Falls Canal, Mich., Hay Lake Channel, St. Mary's River, Mich., 287; Harbor at Cheboygan, Mich., 288; Harbor at Thunder Bay, Mich., Harbor at Au Sable, Mich., Saginaw River, Mich., 289; harbor of refuge at Sand Beach, Lake Huron, Mich., 290; steam-launch or tug for harbor of refuge at Sand Beach, Lake Huron, Mich., ice-harbor of refuge at Belle River, Mich., St. Clair Flats Canal, Mich., 291; operating and care of St. Clair Flats Canal, Mich., 292; Clinton River, Mich., Detroit River, Mich., 293; examinations and survey, 294.

In charge of Maj. L. Cooper Overman, Corps of Engineers—

Monroe Harbor, Mich., 294; Toledo Harbor, Ohio, 295; Port Clinton Harbor, Ohio, Sandusky City Harbor, Ohio, 297; Sandusky River, Ohio, Huron Harbor, Ohio, 298; Vermillion Harbor, Ohio, Black River Harbor, Ohio, 299; Rocky River, Ohio, Cleveland Harbor, Ohio, 300; Fairport Harbor, Ohio, Ashtabula Harbor, Ohio, 302; Conneaut Harbor, Ohio, 303; examinations and surveys, 303.

In charge of Capt. F. A. Mahan, Corps of Engineers—

Erie Harbor, Penn., Dunkirk Harbor, N. Y., 304; Buffalo Harbor, N. Y., 305; Niagara River, N. Y., Wilson Harbor, N. Y., 306; Olcott Harbor, N. Y., Oak Orchard Harbor, N. Y., 307.

In charge of Capt. Carl F. Palfrey, Corps of Engineers—

Charlotte Harbor, N. Y., 308; Pultneyville Harbor, N. Y., Great Sodus Harbor, N. Y., 309; Little Sodus Harbor, N. Y., Oswego Harbor, N. Y., 310; Sackett's Harbor, N. Y., 312.

In charge of Maj. M. B. Adams, Corps of Engineers—

Ogdensburgh Harbor, N. Y., 312; Grass River (at Massena), N. Y., breakwater at Rouse's Point, Lake Champlain, N. Y., 313; Swanton Harbor, Vt., breakwater at Gordon's Landing, Lake Champlain, Vt., Plattsburgh Harbor, N. Y., 314; Burlington Harbor, Vt., Otter Creek, Vt., 315; Ticonderoga River, N. Y., Narrows at Lake Champlain, N. Y. and Vt., 316; examinations, 317.

PACIFIC COAST.

In charge of Col. G. H. Mendell, Corps of Engineers—

Oakland Harbor, Cal., 317; Redwood Harbor, Cal., survey of San Francisco Harbor, San Pablo and Suisun bays, Straights of Carquinez, and mouths of Sacramento and San Joaquin rivers, 318; removing sunken vessels obstructing or endangering navigation, 319.

In charge of Maj. W. H. H. Benyaurd, Corps of Engineers—

Wilmington Harbor, Cal., 319; San Diego Harbor, Cal., surveys of San Diego Harbor, Newport Harbor, and San Luis Obispo Harbor, Cal., 320; survey, 320.

In charge of Capt. A. H. Payson, Corps of Engineers—

Joaquin River, Stockton and Mormon sloughs, Cal., Mokelumne River, Cal., 321; Sacramento and Feather rivers, Cal., 322; Petaluma Creek, Cal., Humboldt Harbor and Bay, Cal., 323; Colorado River, Nev., Cal., and Ariz., 324; examination, 324.

In charge of Capt. Charles F. Powell, Corps of Engineers—

Mouth of the Coquille River, Oregon; entrance to Coos Bay, Oregon, 325; Umpqua River, Oregon, entrance to Yaquina Bay, Oregon, 326; mouth of the Columbia River, Oregon and Wash., 327; construction of canal at the Cascades, Columbia River, Oregon and Wash., Chehalis River, Wash., 328; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., gauging waters of the Columbia River and principal tributaries, Oregon and Wash., 329; examinations and surveys, 330.

IN CHARGE OF MAJ. W. A. JONES, CORPS OF ENGINEERS—

Columbia and Lower Willamette rivers, below Portland, Oregon, Upper Willamette River, Oregon, 331; Upper Columbia and Snake rivers, Oregon and Wash., Lower Clearwater River, Idaho, 332; Cowlitz River, Wash., 333.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS 333

MISCELLANEOUS.

IN CHARGE OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS—

Washington Aqueduct, 333; increasing the water supply of the city of Washington, 334; erection of fish-ways at the Great Falls of the Potomac, 335.

IN CHARGE OF COL. JOHN M. WILSON, U. S. A.—

Improvement and care of Public Buildings and Grounds in the District of Columbia, 336.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge of the Kentucky and Ohio Bridge Company across the Ohio River between Cincinnati, Ohio, and Covington, Ky., bridge of the Staten Island Rapid Transit Company across Arthur Kill, Staten Island Sound, 337; character, etc., of bridge to be constructed across the Mississippi River at Saint Louis, Mo., guiding dike at the bridge of the Pittsburgh and Lake Erie Railroad across the Ohio River at Beaver, Pa., 338; bridge across the Willamette River at or near the city of Portland, Oregon, railway bridge across Red River at Shreveport, La., bridge across the Willamette River at Salem, Oregon, 339; purchase and reconstruction of Aqueduct Bridge, Georgetown, D. C., bridge across the Eastern Branch of the Potomac River, D. C., 340.

MISSISSIPPI RIVER COMMISSION.................... 340

ESTIMATE OF FUNDS FOR THE IMPROVEMENT OF THE MISSISSIPPI RIVER FOR THE FISCAL YEAR ENDING JUNE 30, 1889....... 340

MISSOURI RIVER COMMISSION.................... 341

YELLOWSTONE NATIONAL PARK 342

ANNUAL WATER-LEVELS OF THE NORTHERN AND NORTHWESTERN LAKES................................. 343

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES 343

MILITARY AND GEOGRAPHICAL MAPS 344

RECONNAISSANCES AND EXPLORATIONS 344

ESTIMATE FOR AMOUNT REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DIVISIONS AND DEPARTMENTS....... 345

OFFICE OF THE CHIEF OF ENGINEERS............... 345

STATEMENT SHOWING THE RANK AND THE DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.. 347

LAWS AFFECTING THE CORPS OF ENGINEERS, 49TH CONGRESS, 2D SESSION, 1886-'87.............................. 371

APPENDIX No. 1.

REPORT OF MAJ. WM. R. KING, CORPS OF ENGINEERS.

Post of Willets Point, N. Y.—Engineer School of Application—Battalion of Engineers—Engineer Depot........................ 413

APPENDIX No. 2.

REPORT OF LIEUT S. W. ROESSLER, CORPS OF ENGINEERS.

Library of the School of Application at Willets Point, N. Y.................. 433

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF MAJ. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Lubec Channel, Me., 436; Moose-a-bec Bar, Me., 438; Narraguagus River, Me., 441; Bangor Harbor and Penobscot River, Me., 442; Belfast Harbor, Me., 445; Rockland Harbor, Me., 446; Portland Harbor, Me., 448; channel in Back Cove, Portland, Me., 451; breakwater at mouth of Saco River, Me., 453; Saco River, Me., 455; Kennebunk River, Me., 461; York Harbor, Me., 462; Portsmouth Harbor, N. H., 463; Cocheco River, N. H., 466; harbor of refuge at Little Harbor, N. H., 468.

EXAMINATIONS AND SURVEYS.—Big Rapids of St. John's River, Me., 471; St. George's River, Me., from Warren to Thomaston, 473; Matinicus Isle, Me., with a view to a harbor of refuge, 475; St. Croix River, Me., from Ferry Point Bridge, at Calais, to Breakwater Ledge, 477; Bar Harbor, Me., with the view to establishing a breakwater and deepening the waters of said harbor, and especially the channel between Rodick's Island and Mount Desert Island, 481; Bellamy River, N. H., 484.

APPENDIX B.

REPORT OF LIEUT. COL. GEORGE L. GILLESPIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Newburyport Harbor, Mass., 489; Merrimac River, Mass., 493; Ipswich River, Mass., 495; harbor of refuge, Sandy Bay, Cape Ann, Mass., 497; Gloucester Harbor, Mass., 500; Lynn Harbor, Mass., 508; Boston Harbor, Mass., 511; Malden River, Mass., 520; Hingham Harbor, Mass., 520; Scituate Harbor, Mass., 522; Plymouth Harbor, Mass., 525; Provincetown Harbor, Mass., 528.

APPENDIX C.

REPORT OF MAJ. WM. R, LIVERMORE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 532; harbor of refuge at Nantucket, Mass., 534; Wood's Holl Harbor, Mass., 537; Wareham Harbor, Mass., 540; Westport Harbor, Mass., 543; Taunton River, Mass., 544; Warren River, R. I., 547; Pawtucket River, R. I., 548; Providence River and Narragansett Bay, R, I., 550; removal of Green Jacket Shoal, Providence River, R. I., 553; Newport Harbor, R. I., 554; harbor of refuge at Block Island, R. I., 558; Little Narragansett Bay, R. I. and Conn., 561; harbor of refuge at Stonington, Conn., 562; Pawcatuck River, R. I. and Conn., 565.

EXAMINATIONS AND SURVEYS.—Falmouth Harbor, Mass., 567; Cottage City Harbor, Mass., 568; Menemsha Harbor, Mass., 569; Little Narragansett Bay, entrance to the wharves at Watch Hill, R. I., 571; Vineyard Haven Harbor, Mass., 572.

APPENDIX D.

REPORT OF LIEUT. COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Thames River, Conn., 582; New London Harbor, Conn., 585; Connecticut River, Mass. and Conn., 587; Clinton Harbor Conn., 596; New Haven Harbor, Conn., 597; Breakwater at New Haven, Conn., 602; Milford Harbor, Conn., 604; Housatonic River, Conn., 606; Bridgeport Harbor, Conn., 610; Black Rock Harbor, Conn., 613; Southport Harbor, Conn., 615; Norwalk Harbor, Conn., 616; Stamford Harbor, Conn., 618; Port Chester Harbor, N. Y., 620; Mamaroneck Harbor, N. Y., 622; Echo Harbor, New Rochelle, N. Y., 624; New Rochelle Harbor, N. Y., 626; East Chester Creek, N. Y., 628; Greenport Harbor, N. Y., 630; Port Jefferson Harbor, N. Y., 632; Flushing Bay, N. Y., 634; Removing sunken vessels or craft obstructing or endangering navigation, 636.

EXAMINATIONS.—Peter's Neck Bay, N. Y., 637; Five-Mile River Harbor, Conn., 639; Duck Island Harbor, Conn., on Long Island Sound, 641; Glen Cove Harbor, N. Y., 645.

APPENDIX E.

REPORT OF LIEUT. COL. WALTER McFARLAND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 650; Harbor of Saugerties, N. Y., 660; Harbor at Rondout, N. Y., 663; Harlem River, N. Y., 665; Removing obstructions in the East River and at Hell Gate, N. Y., 689; Newtown Creek, N. Y., 699; Buttermilk Channel, N. Y., 703; Gowanus Bay, N. Y., 709; New York Harbor, 717; Sheepshead Bay, N. Y., 734; Canarsie Bay, N. Y., 737; Sumpawanus Inlet, N. Y., 740; Channel between Staten Island and N. J., 743; Raritan Bay, N. J., 749.

EXAMINATIONS.—Channel between Jamica Bay and Rockaway Inlet, N. Y., 754; East River, with a view to the removal of a ledge of rocks situated between 500 and 600 feet from the foot of Tenth and Eleventh streets, in the city of N. Y., 758; Patchogue River, N. Y., 759.

APPENDIX F.

REPORT OF LIEUT. GEORGE McC. DERBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Passaic River, N. J., 763; Elizabeth River, N. J., 768; Rahway River, N. J., 769; Woodbridge Creek, N. J., 770; Raritan River, N. J., 771; South River, N. J., 773; Cheesequakes Creek, N. J., 775; Keyport Harbor, N. J., 776; Mattawan Creek, N. J., 777; Shrewsbury River, N. J., 778; Manasquan River, N. J., 782.

APPENDIX G.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River, Pa., N. J., 786; Frankford Creek, Pa., 799; Schuylkill River, Pa., 800; Ice-harbor at Marcus Hook, Pa., 802; Ice-harbor at the head of Delaware Bay, Del., 804; Construction of iron pier in Delaware Bay, near Lewes, Del., 804; Harbor at Delaware Breakwater, Del., 805; Rancocas River, N. J., 807; Woodbury Creek, N. J., 808; Mantua Creek, N. J., 809; Raccoon River, N. J., 810; Salem River, N. J., 811; Cohansey Creek, N. J., 812; removal of wrecks from Delaware Bay and River, 813; removing sunken vessels or craft obstructing or endangering navigation, 814; survey for harbor at Atlantic City, N. J., 814; United States Commission advisory to the board of harbor commissioners of Philadelphia, Pa., 820.

EXAMINATIONS.—Channel back of Brigantine Beach, between Absecon and Brigantine Inlets, N. J., 821; Darby Creek, Pa., 822.

APPENDIX H.

REPORT OF MR. WM. F. SMITH, U. S. AGENT.

Improvements.—Maurice River, N. J., 826; Wilmington Harbor, Del., 827; ice-harbor at New Castle, Del., 829; Duck Creek, Del., St Jones River, Del., 831; Mispillion Creek, Del., 833; Broadkiln River, Del., 834; Indian River, Del., 835; inland water-way from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 836; Susquehanna River above and below Havre de Grace, Md., 836; Chester River at Kent Island Narrows, Md., 838; Corsica Creek, Md., 838; Choptank River, Md., 840; Nanticoke River, Del., 842; Broad Creek, Del., from its mouth to Laurel, 843; Wicomico River, Md., 844; Upper Thoroughfare between Deil's Island and the mainland, Md., 846; Pocomoke River, Md., removing sunken vessels or craft obstructing or endangering navigation, 847.

Examinations and surveys.—Duck Creek, Del., 847; Cambridge Harbor, Md., 851; Fairlee Creek, Md., 854.

APPENDIX I.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

Improvements.—Patapsco River and channel to Baltimore, Md., 860; Annapolis Harbor, Md., 863; rebuilding piers at Battery Island, head of the Chesapeake Bay, 864; James River, Va., 867; removing sunken vessels or craft obstructing or endangering navigation, 879.

Examination.—For widening the channel of Baltimore Harbor to 600 feet, 880.

APPENDIX J.

REPORT OF LIEUT. COL. P. C. HAINS, CORPS OF ENGINEERS.

Improvements.—Harbors at Washington and Georgetown, D. C., 883; Potomac River at Washington, D. C., 884; reconstruction of Aqueduct Bridge, D. C., 898; bridge across the Eastern Branch of the Potomac River, D. C., 911; Shenandoah River, W. Va., 925.

APPENDIX K.

REPORT OF MR. S. T. ABERT, U. S. AGENT.

Improvements.—Channel at Mount Vernon, Va., 927; Neabsco Creek, Va., 928; Breton Bay, Leonardtown, Md., 929; Nomini Creek, Va., 932; harbor at entrance of St. Jerome's Creek, Md., 933; Rappahannock River, Va., 935; Totusky River, Va., 938; Urbana Creek, Va., 939; Mattaponi River, Va., 940; Pamunky River, Va., 942; York River, Va., 944; Chickahominy River, Va., 947; Staunton River, Va., 950 and 951; Dan River, between Madison, N. C., and Danville, Va., 953; Roanoke River, N. C., 955; French Broad River, N. C., 958.

Examinations and surveys.—Mattox Creek, Va., 959; Roanoke River, from Clarksville, Va., to Eaton Falls, N. C., 960; Hunter's Creek, Va., 962.

PART II.

APPENDIX L.

REPORT OF CAPT. F. A. HINMAN, CORPS OF ENGINEERS.

Improvements.—Harbor at Norfolk, Va., 963; approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Va., 969; Archer's Hope River, Va., 977; Appomattox River, Va., 978; North Landing River, Va. and N. C., 984; Currituck Sound, Coanjok Bay, and North River Bar, N. C., 986; Blackwater River, Va., 987; Nottoway River, Va., 988; Meherrin River, N. C., Edenton Bay, N. C., 989; removing sunken vessels or craft obstructing or endangering navigation, 990.

Examinations and survey.—Alligator River, N. C., 991; Nansemond River, Va., 995.

APPENDIX M.

REPORT OF CAPT. WILLIAM H. BIXBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Pamlico and Tar rivers, N. C., 1010; Contentnia Creek, N. C., 1013; Trent River, N. C., 1016; Neuse River, N. C., 1020; inland water-way between New Berne and Beaufort, N. C., 1026; harbor at Beaufort, N. C., 1030; inland water-way between Beaufort Harbor and New River, N. C., through Bogue Sound, 1037; New River, N. C., 1039; Black River, N. C., 1042; Cape Fear River, N. C., 1044; Yadkin River, N. C., 1061; Waccamaw River, S. C., 1065; Great Pee Dee River, S. C., 1070; harbor at Georgetown, S. C., 1074; Winyaw Bay, S. C., 1078; Santee River, S. C., 1081; Wateree River, S. C., 1089; Congaree River, S. C., 1093; removing sunken vessels or craft obstructing or endangering navigation, 1097.

EXAMINATIONS AND SURVEYS.—Lockwood Folly River, N. C., 1099; Lumber River, N. C., 1102; Mingo Creek, S. C., 1106; Clark's Creek, S. C., 1109; Little Pee Dee River, S. C., 1111; Alligator River and other waters connecting Santee River and Bull's Bay, S. C., 1114.

APPENDIX N.

REPORT OF COL. Q. A. GILLMORE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Charleston Harbor, S. C., 1125; Wappoo Cut, S. C., 1138; Ashley River, S. C., 1141; Edisto River, S. C., 1143; Salkahatchie River, S. C., 1146; Savannah Harbor and River, Ga., 1150; Savannah River, Ga., 1165; Savannah River, above Augusta, Ga., 1172; St. Augustine Creek (Thunderbolt River), Ga., 1174; Romerly Marsh, Ga., 1174; Altamaha River, Ga., 1176; Doboy Bar, Ga., 1179; Brunswick Harbor, Ga., 1184; entrance to Cumberland Sound, Ga. and Fla., 1191; inside passage between Fernandina and St. John's River, Fla., 1199.

EXAMINATION.—From Doboy Island to Doboy Bay, Ga., 1199.

APPENDIX O.

REPORT OF CAPT. WM. M. BLACK, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. John's River, Fla., 1207; Volusia Bar, Fla., 1216; Upper St. John's River, Fla., 1219; Survey of entrance to harbor of Key West, Fla., 1221; Caloosahatchie River, Fla., 1235; Pease River, Fla., 1237; Manatee River, Fla., 1239; Tampa Bay, Fla., 1243; Withlacoochee River, Fla., 1248; Harbor at Cedar Keys, Fla., 1251; Suwanee River, Fla., 1253; Removing sunken vessels or craft obstructing or endangering navigation, 1256.

EXAMINATIONS.—Tampa Bay, Fla., including Hillsborough River up to the city of Tampa, 1257; Charlotte Harbor, including San Carlos Bay, Fla., 1258; Clearwater Harbor, including Anclote and St. Joseph's bays and the Narrows into Boca Ciega Bay, Fla., 1259; Wakulla River, Fla., from its mouth to Wakulla Springs, 1260; Channel from Haulover, on Indian River, to Gilbert's Bar, Fla., 1261.

APPENDIX P.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Apalachicola River, Fla., 1263; Apalachicola Bay, Fla., 1265; La Grange Bayou, Fla., 1268; Pensacola Harbor, Fla., 1269; Choctawhatchee River, Fla., and Ala., 1271; Escambia and Conecuh rivers, Fla. and Ala., 1273; Oconee River, Ga., 1275; Ocmulgee River, Ga., 1276; Oostenaula and Coosawattee rivers, Ga., Flint River, Ga, 1278; Coosa River, Ga. and Ala., 1281; Chattahoochee River, Ga. and Ala., 1283; Tallapoosa River, Ala., 1285; Cahawba River, Ala., 1287; Alabama River, Ala., 1288.

EXAMINATION.—Flint River, Ga., from Montezuma to Old Agency, 1290.

APPENDIX Q.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1293; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., 1299; Warrior River, Ala., 1322; Tombigbee River, from Fulton to Vienna, 1324; Tombigbee River, below Vienna, 1327; Old Town Creek, Miss., 1327; Noxubee River, Miss., 1328; Pascagoula River, Miss., 1330; Harbor at Biloxi Bay, Miss., 1333; Pearl River, Miss., between Edinburgh and Carthage, 1334; Pearl River, Miss., from Jackson to Carthage, 1336; Pearl River, Miss., below Jackson, 1339.

EXAMINATION.—Noxubee River, Miss., to ascertain whether it can be made continuously navigable by a system of locks and dams, or otherwise, 1343.

APPENDIX R.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

Inspection-improvement at the South Pass of the Mississippi River.......... 1,345

APPENDIX S.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tchefuncte River and Bogue Falia, La., 1358; Tangipahoa River, La., 1361; Tickfaw River, La., 1362; Amite River, La., 1364; Bayou La Fourche, La., 1365; Bayou Terrebonne, La., 1367; Bayou Black, La., 1368; Bayou Teche, La., 1370; Connecting Bayou Teche with Grand Lake at Charenton, La., 1374; Bayou Courtableau, La., 1375; Calcasieu River and Pass, La., 1378; Bayou Pierre, Miss., 1382; Sabine River, La. and Tex., 1383; Neches River, Tex., 1384; Sabine Pass, Tex., 1385; Removal of sunken vessels or craft obstructing or endangering navigation, 1392.

EXAMINATIONS AND SURVEY.—Bayou Rouge, La., 1393; Bayou Terrebonne, La., from Houma to Thibodeaux, 1396; Bayou Vermillion, La., to secure navigation from Abbeville to the railroad bridge of the Louisiana and Texas Railroad, 1398; Mouth of Calcasieu River and of Calcasieu Pass, La., 1402; Mouth of Bayou Plaquemine, with a view to its connection with the Mississippi River by locks; also Bayou Plaquemine and other connecting streams, to form the best route to Grand Lake, La., 1405.

APPENDIX T.

REPORT OF MAJ. O. H. ERNST, CORPS OF ENGINEERS.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1415; ship channel in Galveston Bay, Tex., 1417; Trinity River, Tex., 1421; Buffalo Bayou, Tex., 1423; mouth of Brazos River, Tex., 1427; Pass Cavallo Inlet to Matagorda Bay, Tex., 1429; Aransas Pass and Bay, up to Rockport and Corpus Christi, Tex., 1431; harbor at Brazos Santiago, Tex., 1433; protection of river bank at Fort Brown, Tex., 1434.

EXAMINATION.—Cedar Bayou, Tex., where it empties into Galveston Bay, 1435.

APPENDIX U.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Red River, La. and Ark., 1440; Cane River, La., 1452; survey of Bayou Pierre, La., Cypress Bayou, Tex. and La., 1453; Loggy Bayou, Lake Bistineau, and the Dorcheat, La., 1454; Ouachita and Black rivers, Ark. and La., 1455; Bayou D'Arbonne, La., 1458; Bayou Bartholomew, La. and Ark., 1459; Bayou Boeuf, La., 1461; Tensas River and Bayou Macon, La., 1463; Big Black River, Miss., 1465; Yazoo River, Miss., 1467; Tchula Lake, Miss., 1471; Yallabusha River, Miss., 1473; Tallahatchee River, Miss., 1474; Steele's Bayou, Miss., 1476; Big Sunflower River, Miss., 1477; Big Hatchie River, Tenn., 1479; South Forked Deer River, Tenn., 1482; water-gauges on the Mississippi River and its principal tributaries, 1485.

Examinations.—Ouachita River, La., from Camden to mouth, with a slackwater navigation, 1487; Cornay River, La., Dugdemona River, La., 1489; the lakes connecting with Red River between Shreveport, La., and Fulton, Ark., also Clear Lake, Black Bayou, Red Bayou, Black Lake, and Kelly Bayou, to re-open navigable communication between those streams and Red River, La., 1490; Cypress Bayou, La., North Fork of Forked Deer River below Dyersburgh, Tenn., 1494; Ouachita River above Camden, Ark., 1495; Cassity Bayou, Miss., Bayous Rondeway and Vidal, La., 1497; Little River, La., 1498.

APPENDIX V.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

Improvements.—Red River above Fulton, Ark., 1502; Little Red River, Ark., 1503; Saline River, Ark., 1505; removing obstructions in Arkansas River, Ark., 1506; Arkansas River, Ark., 1510; survey of Arkansas River, Ark., from Little Rock to its mouth, 1528; Petit Jean River, Ark., 1529; Fourche River, Ark., 1531; White River, Ark., 1534; Black River, Ark. and Mo., 1537; St. Francis River, Ark., 1539; L'Anguille River, Ark., 1543.

Examinations.—Little River, Ark., 1545; Saline River, Ark., 1546; Cache River, Ark., 1547; Little River, Mo., from Hornersville to its junction with the St. Francis River, 1548; St. Francis River, from Greenville, Mo., to the Arkansas State line, 1549.

APPENDIX W.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

Improvements.—Removing snags and wrecks from the Mississippi and Missouri rivers, 1553; Mississippi River between the Ohio and Illinois rivers, 1556; Gasconade River, Mo., 1590; Osage River, Mo. and Kans., 1591.

Examination.—Osage River from its mouth to Osceola, with a view to movable locks and dams, or other methods of improvement, 1593.

APPENDIX X.

REPORT OF CAPT. C. B. SEARS, CORPS OF ENGINEERS.

Improvements.—Missouri River, from Sioux City, Iowa, to Fort Benton, Mont., 1597; Yellowstone River, Mont. and Dak., 1601.

Examination.—James (Dakota) River, Dak., 1603.

APPENDIX Y.

REPORT OF CAPT. E. H. RUFFNER, CORPS OF ENGINEERS.

Improvement.—Mississippi River, between the Des Moines Rapids and the mouth of the Illinois River, 1607.

Examination.—Bars in Hamburg Bay, Ill., 1616.

APPENDIX Z.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

Improvements.—Upper Mississippi River, operations of snag boats and dredge boats, etc., 1617; Mississippi River, from Des Moines Rapids to mouth of the Illinois River, 1623; Mississippi River, from Saint Paul to Des Moines Rapids, 1623; Des Moines Rapids, Mississippi River, 1639; operating and care of Des Moines Rapids Canal, 1644; dry-dock at Des Moines Rapids Canal, 1651; removal of bar in Mississippi River, opposite Dubuque, Iowa, 1653; ice harbor at Dubuque, Iowa, 1656; harbors of refuge on Lake Pepin, at Lake City, Minn., 1657; Harbors of refuge on Lake Pepin, at Stockholm, Wis., 1658.

APPENDIX A A.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Preservation of the Falls of St. Anthony, Minn., 1660; construction of lock and dam on the Mississippi River at Meeker's Island, Minn., 1663; Mississippi River, above the Falls of St. Anthony, Minn., 1664; reservoirs at headwaters of the Mississippi River, 1666; Chippewa River, Wis., 1699; Chippewa River at Yellow Banks, Wis., 1703; St. Croix River, below Taylor's Falls, Minn. and Wis., 1705; Minnesota River, Minn., 1710; Red River of the North, Minn. and Dak., 1712; construction of lock and dam at Goose Rapids, Red River of the North, Minn. and Dak., 1721.

EXAMINATIONS.—Harbor at Hudson, Lake St. Croix, Wis., 1723; Red Lake River, from Grand Forks to Red Lake, Minn., 1724; causes of the extraordinary overflows of the Chippewa River, Wis., and what means, if any, can be adopted to prevent their recurrence, 1726; Red River of the North, Minn., from Moorehead to Fergus Falls, 1733.

PART III.

APPENDIX B B.

REPORT OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, 1737; French Broad River, Tenn., 1751; Little Tennessee River, Tenn., 1752; Hiawassee River, Tenn., 1754; Clinch River, Tenn., 1755; Duck River, Tenn., 1757; Cumberland River, Tenn. and Ky., 1758; South Fork of Cumberland River, Ky., 1765; Caney Fork River, Tenn., 1766.

EXAMINATIONS.—Caney Fork River, Tenn., 1768; Holston River, Tenn., 1772.

APPENDIX C C.

REPORT OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 1782; operating and care of Davis Island Dam, Ohio River, 1796; Monongahela River, W. Va. and Pa., 1800; operating and care of Lock and Dam No. 9, Monongahela River, 1809; Alleghany River, Pa., 1810; dam at Herr's Island, Allegheny River, 1811; ice harbor at mouth of Muskingum River, Ohio, 1813; operating and care of the locks and dams on the Muskingum River, Ohio, 1815; harbor of refuge near Cincinnati, Ohio, harbor of refuge at mouth of Great Kanawha River, W. Va., 1822; Big Sandy River, W. Va. and Ky., 1823; Guyandotte River, W. Va., 1827; Little Kanawha River, W. Va., 1828; Buckhannon River, W. Va., 1832.

EXAMINATIONS.—For ice harbor at Paducah, Ky., 1833; bar at the mouth of Limestone Creek, in the harbor of Maysville, Ky., 1834; Big Hockhocking River, Ohio, from its mouth to Coolville, 1835.

APPENDIX D D.

REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio, Louisville, Ky., 1838; Indiana Chute, Falls of the Ohio River, 1842; operating and care of the Louisville and Portland Canal, 1843; Wabash River, Ind. and Ill., 1864; White River, Ind., 1871; Kentucky River, Ky., 1872; operating and keeping in repair locks and dams on the Kentucky River, Ky., 1885; improvement of Tradewater River, Ky., 1895.

EXAMINATIONS.—Whether or not the Government dry-dock at the Louisville and Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making the same, 1896; Pond River, Ky., 1901; Louisa [Levisa] Fork of Sandy River, Va., Licking River, Ky., from Farmers to West Liberty, 1902; report upon the commercial importance of the works of the Green and Barren River Navigation Company, 1903.

APPENDIX E E.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

Improvements.—Great Kanawha River, W.Va., 1911; Elk River, W.Va., 1923; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 1925.
Examination.—Coal River, W. Va., 1929.

APPENDIX F F.

REPORT OF CAPT. JAMES B. QUINN, CORPS OF ENGINEERS.

Improvements.—Harbor at Duluth, Minn., 1935; harbor at Superior Bay and Saint Louis Bay, Wis., 1945; harbor at Agate Bay, Minn., 1951; harbor at Grand Marais, Minn., 1954.

APPENDIX G G.

REPORT OF CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS.

Improvements.—Ashland Harbor, Wis., 1957; Ontonagon Harbor, Mich., 1967; Eagle Harbor, Mich., 1970; establishment and maintenance of harbor-lines in Portage Lake, Mich., 1971; Marquette Harbor, Mich., 1995; harbor of refuge, Grand Marais, Mich, 1999; Manistique Harbor, Mich., 2001; Cedar River Harbor, Mich., 2002; Menomonee Harbor, Mich. and Wis., 2004; Oconto Harbor, Wis., 2006; Pensaukee Harbor, Wis., 2010; Green Bay Harbor, Wis., 2012; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 2014; Ahnapee Harbor, Wis., 2037; Kewaunee Harbor, Wis., 2040; Two Rivers Harbor, Wis., 2043; Manitowoc Harbor, Wis., 2044; Sheboygan Harbor, Wis., 2047; Port Washington Harbor, Wis., 2050.
Examination.—Torch Lake Channel, Lake Superior, Mich., 2053.

APPENDIX H H.

REPORT OF CAPT. W. S. MARSHALL, CORPS OF ENGINEERS.

Improvements.—Harbor of refuge, Milwaukee Bay, Wis., 2055; Milwaukee Harbor, Wis., 2061; Racine Harbor, Wis., 2069; Kenosha Harbor, Wis, 2072; Waukegan Harbor, Ill., 2074; Fox and Wisconsin rivers, Wis., 2077.

APPENDIX I I.

REPORT OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS.

Improvements.—Chicago Harbor, Ill., 2109; Calumet Harbor, Ill., 2117; Illinois River Ill., 2119; Calumet River, Ill. and Ind., 2167.
Examinations and survey.—For Hennepin Canal, Farm Creek, Ill., with a view to changing its course, 2171; Calumet River, Ill., from the forks of the river near its entrance into Lake Calumet to Riverdale, and also from Riverdale to Blue Island, 2172.

APPENDIX J J.

REPORT OF CAPT. D. W. LOCKWOOD, CORPS OF ENGINEERS.

Improvements.—Charlevoix Harbor and entrance to Pine Lake, Mich., 2176; Frankfort Harbor, Mich., 2179; harbor of refuge at Portage Lake, Mich., 2180; Manistee Harbor, Mich., 2182; Ludington Harbor, Mich., 2184; Pentwater Harbor, Mich., 2186; White River Harbor, Mich., 2187; Muskegon Harbor, Mich., 2189; Grand Haven Harbor, Mich., 2191; Grand River, Mich., 2193; Black Lake Harbor, Mich., 2194; Saugatuck Harbor, Mich., 2196; South Haven Harbor, Mich., 2198; Saint Joseph Harbor, Mich., 2200; Michigan City Harbor, Ind., 2202.

EXAMINATIONS.—Grand River, Mich., 2206; Pigeon River, Mich., 2207; Carp River, Mich., at Leland, with a view to affording an entrance to Carp Lake for harbor of refuge, 2208; Lake Michigan, at Empire, with a view to cutting a channel across the bar from Lake Michigan to Bar Lake, 2209; Grand Traverse Bay, with a view to connecting it with Torch Lake, near Eastport, Mich., 2210.

APPENDIX K K.

REPORT OF LIEUT. COL. O. M. POE, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Mary's Falls Canal and River, Mich., 2214; operating and care of St. Mary's Falls Canal, Mich., 2227; dry-dock at St. Mary's Falls Canal, Mich., Hay Lake Channel, St. Mary's River, Mich., 2238; harbor at Cheboygan ,Mich., 2247; harbor at Thunder Bay, Mich., 2249; harbor at Au Sable, Mich., Saginaw River, Mich., 2250; harbor of refuge at Sand Beach, Lake Huron, Mich., 2256; steam-launch or tug for harbor of refuge at Sand Beach, Lake Huron, Mich., 2261; ice-harbor of refuge at Belle River, Mich., St. Clair Flats Canal, Mich., 2262; operating and care of St. Clair Flats Canal, Mich., 2264; Clinton River, Mich., 2265; Detroit River, Mich., 2266.

EXAMINATIONS AND SURVEYS.—Bar in St. Clair River, Mich., opposite St. Clair City, 2270; North River, Mich., between Essex and north bridges, Biddle's Point at Mackinac Harbor, Mich., with a view to a breakwater, 2271; harbor at Forrestville, Lake Huron, Mich., 2273; Pinepog River, Mich., 2274; Rouge River, Mich., at its junction with Detroit River, and up the river to bridge of St. Louis and Wabash Railroad, 2275; mouth of Black River, Saint Clair County, Mich., 2279.

APPENDIX L L.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 2281; Toledo Harbor, Ohio, 2283; Port Clinton Harbor, Ohio, 2299; Sandusky City Harbor, Ohio, 2302; Sandusky River, Ohio, 2305; Huron Harbor, Ohio, 2307; Vermillion Harbor, Ohio, 2310; Black River Harbor, Ohio, 2312; mouth of Rocky River, Ohio, 2315; Cleveland Harbor, Ohio, 2317; Fairport Harbor, Ohio, 2324; Ashtabula Harbor, Ohio, 2327; Conneaut Harbor, Ohio, 2332.

EXAMINATIONS AND SURVEYS.—Chagrin River, at its mouth, Ohio, 2333; Sandusky Harbor, Ohio, with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city, 2335.

APPENDIX M M.

REPORT OF CAPT. F. A. MAHAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 2343; Dunkirk Harbor, N. Y., 2348; Buffalo Harbor, N. Y., 2351; Niagara River, N. Y.; Wilson Harbor, N. Y., 2366; Olcott Harbor, N. Y., 2368; Oak Orchard Harbor, N. Y., 2369.

APPENDIX N N.

REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Charlotte Harbor, N. Y., 2371; Pultneyville Harbor, N. Y., 2374; Great Sodus Harbor, N. Y., 2376; Little Sodus Harbor, N. Y., 2379; Oswego Harbor, N. Y., 2381; Sackett's Harbor, 2391.

APPENDIX O O.

REPORT OF MAJ. M. B. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS:—Ogdensburgh Harbor, N. Y., 2393; Grass River (at Massena), N. Y., 2396; Breakwater at Rouse's Point, Lake Champlain, N. Y., 2397; Swanton Harbor, Vt., 2399; breakwater at Gordon's Landing, Lake Champlain, Vt., 2400; Plattsburgh Harbor, N. Y., 2405; Burlington Harbor, Vt., 2406; Otter Creek, Vt., 2410; Ticonderoga River, N. Y., Narrows at Lake Champlain, N. Y. and Vt., 2411.

EXAMINATIONS.—Channel between North and South Hero Islands, Lake Champlain, known as "The Gut," 2412; Waddington Harbor, N. Y., 2414.

APPENDIX P P.

ANNUAL WATER-LEVEL CURVES OF THE NORTHERN AND NORTHWESTERN LAKES .... 2417.

APPENDIX Q Q.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Oakland Harbor, Cal., 2419; Redwood Harbor, Cal., 2424; San Francisco Harbor, San Pablo and Suisun bays, Straits of Carquinez, and mouths of Sacramento and San Joaquin rivers, removing sunken vessels obstructing or endangering navigation, 2426.

APPENDIX R R.

REPORT OF MAJ. W. H. H. BENYAURD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Wilmington Harbor, Cal., 2429; San Diego Harbor, Cal., 2431.
SURVEYS.—San Diego, Newport, and San Luis Obispo harbors, Cal., 2432.

APPENDIX S S.

REPORT OF CAPT. A. H. PAYSON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Joaquin River, Stockton and Mormon sloughs, Cal., 2437; Mokelumne River, Cal., Sacramento and Feather rivers, Cal., 2441; Petaluma Creek, Cal., 2446; Humboldt Harbor and Bay, Cal., 2447; Colorado River, Nev., Cal., and Ariz., 2449.
EXAMINATIONS.—Mouth of Smith's River, Cal., 2450; Crescent City Harbor, Cal., with a view to a sea-wall from Battery Point to Flat Rock, 2454.

APPENDIX T T.

REPORT OF CAPT. CHAS. F. POWELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mouth of the Coquille River, Oregon, 2458; entrance to Coos Bay, Oregon, 2460; Umpqua River, Oregon, 2463; entrance to Yaquina Bay, Oregon, 2465; mouth of the Columbia River, Oregon and Wash., 2470; construction of canal at the Cascades, Columbia River, Oregon and Wash., 2476; Chehalis River, Wash., 2489; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 2490; gauging waters of the Columbia River and principal tributaries, Oregon and Wash., 2491.
EXAMINATIONS AND SURVEYS.—Siuslaw River and Bar, Oregon, 2493; Nehalem Bay and Bar, Oregon, 2496; Coquille River, between Coquille City and Myrtle Point, Oregon, 2498; Umpqua River, Oregon, 2499.

APPENDIX U U.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Columbia and Lower Willamette rivers, below Portland, Oregon, 2507; Upper Willamette River, Oregon, 2517; Upper Columbia and Snake rivers, Oregon, and Wash., 2520; Lower Clearwater River, Idaho, 2523; Cowlitz River, Wash., 2524.

PART IV.

APPENDIX V V.

REPORT OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Washington Aqueduct, 2527; increasing the water supply of the city of Washington, D. C., 2535; erection of fish-ways at the Great Falls of the Potomac, 2564.

APPENDIX W W.

REPORT OF COL. JOHN M. WILSON, U. S. A.

Improvement and care of public buildings and grounds in the District of Columbia, 2569.

APPENDIX X X.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge of the Kentucky and Ohio Bridge Company across the Ohio River between Cincinnati, Ohio, and Covington, Ky., 2613; bridge of the Staten Island Rapid Transit Company across Arthur Kill, Staten Island Sound, 2632; character, etc., of bridge to be constructed across the Mississippi River at Saint Louis, Mo., 2638; guiding dike at the bridge of the Pittsburgh and Lake Erie Railroad across the Ohio River at Beaver, Pa., 2655; bridge across the Willamette River at or near the city of Portland, Oregon, 2661; railway bridge across Red River at Shreveport, La., 2671; bridge across the Willamette River at Salem, Oregon, 2682.

APPENDIX Y Y.

REPORTS OF THE MISSISSIPPI RIVER COMMISSION.

Q. A. GILLMORE, Col. of Engineers, Bvt. Maj. Gen., U. S. A., *President.*
C. B. COMSTOCK, Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.,
CHARLES R. SUTER, Major of Engineers, U. S. A.,
Mr. HENRY MITCHELL, Coast and Geodetic Survey,
Mr. B. M. HARROD, Civil Engineer,
Mr. S. W. FERGUSON, Civil Engineer,
Mr. ROBERT S. TAYLOR,
Commissioners.

1.

Annual report for 1885-'86, 2689; surveys and examinations, 2697; report of committee on construction, 2710; Mississippi River between the Des Moines Rapids and the mouth of the Illinois River, 2719; Mississippi River between the mouths of the Illinois and Ohio rivers, 2722; operations in the first district, 2724; operations in the second district, 2731; operations in the third district, 2736; operations in the fourth district, 2744.

2.

Supplemental report: Operations from July 1 to November 1, 1886, 2749.

3.

Annual report for 1886-'87, 2753; surveys and examinations, 2769; report of committee on construction, 2864; operations in first district, 2873; operations in second district, 2878; operations in third district, 2881; operations in fourth district, 2893.

APPENDIX Z Z.

REPORTS OF THE MISSOURI RIVER COMMISSION.

Charles R. Suter, Major of Engineers, U. S. A., *President.*
Alex. Mackenzie, Major of Engineers, U. S. A.,
O. H. Ernst, Major of Engineers, U. S. A.,
Mr. G. C. Broadhead,
Mr. William J. Broatch,
Commissioners.

1.

Annual report for 1885-'86, 2913; report of the secretary, 2921; operations upon Missouri River between Sioux City, Iowa, and Fort Benton, Mont., 3022.

2.

Reports respecting allotment of appropriation of August 5, 1886, 3026.

3.

Annual report for 1886-'87, 3031; report of the secretary, 3036; report of president, 3096; report of secretary on special surveys, 3111; report of secretary on obstruction to navigation at Camden, Mo., 3119; instruments and methods used in taking and reducing sediment and velocity observations on the Mississippi, Missouri, and Arkansas rivers, 3121; report on redetermination of standard steel tape from measurement of entire Olney Base, etc., 3124.

APPENDIX A A A.

REPORT OF CAPT. CLINTON B. SEARS, CORPS OF ENGINEERS.

Construction and improvement of roads and bridges in the Yellowstone National Park, 3133.

APPENDIX B B B.

REPORT OF LIEUT. COL. O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A.

Issue of published charts of the northern and northwestern lakes, 3143.

APPENDIX C C C.

REPORT OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS.

Explorations and surveys in the division of the Missouri, 3145.

APPENDIX D D D.

REPORT OF LIEUT. THOMAS L. CASEY, CORPS OF ENGINEERS.

Explorations and surveys in the department of California, 3147.

APPENDIX E E E.

REPORT OF LIEUT. JOHN BIDDLE, CORPS OF ENGINEERS.

Explorations and surveys in the Department of Dakota, 3149.

APPENDIX F F F.

REPORT OF LIEUT. WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

Explorations and surveys in the Department of the Columbia, 3151.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX L.

IMPROVEMENT OF THE HARBOR AT NORFOLK, VIRGINIA; APPROACH TO NORFOLK HARBOR, VIRGINIA; CURRITUCK SOUND, COANJOK AND EDENTON BAYS, AND NORTH RIVER BAR, NORTH CAROLINA—IMPROVEMENT OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

REPORT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Norfolk, Va.
2. Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Virginia.
3. Archer's Hope River, Virginia.
4. Appomattox River, Virginia.
5. North Landing River, Virginia and North Carolina.
6. Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.
7. Blackwater River, Virginia.
8. Nottoway River, Virginia.
9. Meherrin River, North Carolina.
10. Edenton Bay, North Carolina.
11. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEY.

12. Alligator River, North Carolina.
13. Nansemond River, Virginia.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., July 30, 1887.

GENERAL: I have the honor to transmit herewith my annual report upon the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L 1.

IMPROVEMENT OF HARBOR AT NORFOLK, VIRGINIA.

The act of August 5, 1886, appropriated $50,000 for this work. A project (copy herewith) for the expenditure thereof was submitted to the Chief of Engineers and duly approved.

In accordance therewith, on October 12, 1886, proposals we invited for dredging in the Southern Branch, and on November 22, 1886, a contract was entered into with the Morris and Cumings Dredging Company of New York City, the lowest bidder, in accordance with the specifications, to do the work at 15.5 cents per cubic yard, measured in scows.

The company began work December 24, 1886, and completed it March 9, 1887, removing 265,570 cubic yards of material in that time. This work resulted in a channel at least 25 feet deep and from 125 to 500 feet wide, at mean low water, from the mouth of the Southern Branch to the upper end of the navy-yard. The removal of a few more thousand yards of material and of two marine railway obstructions belonging to Mr. John L. Thomas and Mr. William B. Thomas, respectively, will complete the project to secure a channel at least 25 feet deep and not less than 500 feet wide, at mean low water, through the said portion of the Southern Branch. In compliance with the provisions of section 4 of said act, a report (copy herewith) was made on the said obstructions. The accompanying map will illustrate the foregoing.

The ship *Prinz Hendrik* passed out of this port on March 11, 1887, at high water, drawing 25 feet.

Cursory examinations during the year show that this work has not materially deteriorated, the ruling depth being 24 feet at mean low water, except in the Eastern Branch, where the dredged channel has shoaled near the mouth to 21 feet at mean low water, which was to be expected under the circumstances heretofore reported, and also in the vicinity of Buoy No. 2, at Sewall's Point Bar, where the dredged channel has shoaled to 21 feet at mean low water. It is possible that the contemplated survey of this will show that that portion of the straight channel dregded under the direction of my predecessors may have to be abandoned for the natural channel further inshore, which, it is understood deep-draught vessels now navigate. The buoyage of the approach to the harbor was much improved during the year, so that the dredged channel through Sewall's Point Bar is now better defined than formerly.

On August 14, 1886, proposals were invited for furnishing, building, and delivering a steam tender (the *Lucerne*) 75 by 14 by 6¼ feet, a plan and specifications for which had been prepared in this office, for use on this and other works, and, on September 21,1886, a contract was entered into with Messrs. E. J. Codd & Co., of Baltimore, Md., the lowest bidders, to deliver the same at Norfolk, Va., on December 30, 1886, for $10,900. Owing to unfavorable weather, which retarded work, the contractors asked, on December 22, 1886, for an extension of the time for delivery until January 25, 1887, which was granted. She was finished accordingly, accepted and paid for by allotments from the appropriations for works specified below, as follows:

Improving harbor at Norfolk, Va	$1,700
Improving harbor at Norfolk, Va., and its approaches	1,700
Improving approach to Norfolk Harbor and the United States (Norfolk) navy-yard, Virginia	6,000
Improving Currituck Sound and North River Bar, North Carolina	1,500
Total	10,900

The contractors did all in their power to produce a fine boat and succeeded. The *Lucerne* is admirably adapted to the needs of the district and has been of great service therein.

The funds available will be applied to contingencies. The sum of $457,744.56 can be profitably expended in the fiscal year ending June 30, 1889, with which it is proposed to complete the improvement as projected (for details see Report of the Chief of Engineers, 1885), to the great benefit of navigation, commerce, and to the United States (Norfolk) navy-yard.

The portion of the approach to the harbor between Lambert's Point and Fort Norfolk is not included herein, as it is now a work by itself. However, these works are so intimately connected that the statistics relative to one will apply to the other.

The Committee on Commerce state as follows relative to them, in Senate Report No. 1391, first session, Forty-ninth Congress:

> The importance of these works is so very obvious that the committee do not deem it necessary to describe their situation.

The accompanying statistics relative to exports, imports, cotton, grain, and coal well set forth the benefits that the large territory surrounding the harbor has received from the comparatively small amount of money that has been expended by the Government in improving it, and should prove conclusively that the completion of the proposed improvement will advance the interests of commerce and the navy-yard and benefit the community enormously. The coastwise trade in truck, oysters, peanuts, lumber, etc., is very large and still increasing. Another new railroad is being built to this point, and the Western Branch trucking lands, opposite Lambert's Point, are being wonderfully developed by railroads, etc. This is certainly a very prosperous and enterprising community. Capitalists realize this fact and seek investments here. For other statistics, see those in the report for this fiscal year on North Landing River, Virginia and North Carolina.

It is understood that this port draws cotton from the immediate vicinity of other ports, owing to its greater depth, fine compresses, cheaper freights, etc. The large dry-dock now being constructed at Newport News, opposite here, will advance the interests of this port incidentally, and the proposed Government dry-dock at the navy-yard will benefit it.

Norfolk is a port of entry.

Money statement.

July 1, 1886, amount available	$1,887.41
Amount received from an officer for fuel	33.75
Amount appropriated by act approved August 5, 1886	50,000.00
	51,921.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	49,151.34
July 1, 1887, amount available	2,769.82
Amount (estimated) required for completion of existing project	457,744.56
Amount that can be profitably expended in fiscal year ending June 30, 1889	457,744.56
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

PROJECT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., August 16, 1886.

GENERAL: In accordance with your instructions of the 12th instant, I have the honor to submit the following project for the expenditure of the sum of $187,500, appropriated by the act of August 5, 1886, for—

> Improving harbor at Norfolk, Va., and improving approach to Norfolk Harbor and the United States navy-yard at Norfolk. Continuing improvement by widening the channel of Elizabeth River to the port-warden's line on the eastern side, between

Lambert's Point Light and Fort Norfolk, $187,500; of which $50,000 shall be exp in improving the harbor and $137,500 in widening the channel of Elizabeth Riv the port-warden's line on the eastern side, between Lambert's Point Light and Norfolk, beginning at Lambert's Point Light, including the construction of the posed dike.

The river and harbor act of 1876 had an item for "Improving ha at Norfolk, Va." Those for 1878, 1879, 1880, 1881, and 1882 had i for "Improving harbor at Norfolk and its approaches, Virginia." act of 1884 had two items, one for "Improving harbor at Norfolk its approaches, Virginia," and the other for "Improving approa Norfolk Harbor and the United States (Norfolk) navy-yard, Virgi It will be noticed that the item under consideration does not mea "the approaches" *generally*, but does *particularize* a *part* of th proaches.

It is unfortunate that the cut through Sewall's Point Bar can no widened under this appropriation, as that is now the most urgent to be done.

* * * * * * *

The plan and project now in process of execution for the harbor its approaches is: (1) To secure a channel not less than 25 feet and 500 feet wide at ordinary low water, by dredging from the water of Hampton Roads to Norfolk and the United States navy- on the Southern Branch, and also to secure a channel, at the s stage, in the Eastern Branch, not less than 22 feet deep, having a w of at least 300 feet at the Norfolk and Western Railroad Bridge, gradually increasing to about 700 feet at its mouth, by dredging tween said points, and (2) to ultimately dredge the entire area boun by lines parallel to and 75 feet from the port-warden lines to a de of not less than 25 feet at ordinary low water from Fort Norfolk to United States navy-yard, and not less than 22 feet deep from mouth of the Eastern Branch to Campostella Bridge, and to const a bulkhead at Berkley Flats.

* * * * * * *

The balance of the channel (all except that from Lambert's Poin Fort Norfolk) from the deep water of Hampton Roads to the Un States navy-yard on the Southern Branch is not less than 200 wide, with a ruling depth of 24 feet at same stage. The channel in Eastern Branch is at least 22 feet deep and not less than 200 feet w at same stage up to the Norfolk and Western Railroad Bridge.

It is proposed to expend the aforesaid amount as follows:

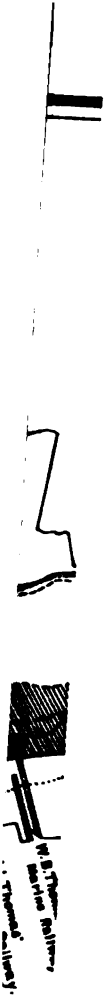
NORFOLK HARBOR.

To dredge the channel of the Southern Branch from its mouth to upper end of the navy-yard, as set forth in my annual report, on pa 1016, Report of the Chief of Engineers, 1885, so that it shall be less than 500 feet wide and at least 25 feet deep at mean low wat (See accompanying map.) This will require the removal of 248, cubic yards of material, measured in situ, which, at 18 cents, wo amount to $44,694, or $45,000 in round numbers.

RECAPITULATION.

Dredging Southern Branch	$45,
Amount appropriated by act of August 5, 1886	50,
Balance	5,

* * * * * * *


W.B.Tho
Marine Railw
Thomas'
ailway.

It is respectfully recommended that all the foregoing be done by contract after advertising thirty days for proposals, it being most economical and advantageous to the Government to do so, and that the balance be held for contingencies.

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Lieut. Col. William P. Craighill,
Corps of Engineers, U. S. A.)

COMMERCIAL STATISTICS.

Statistics relative to port of Norfolk, Va., for the fiscal year ending June 30, 1887, *received from W. R. Mayo, esq., collector.*

Imports.				Exports.			
Articles.	Designation.	Quantities.	Values.	Articles.	Designation.	Quantities.	Values.
Salt	Pounds	31, 836, 768	$52, 598	Cotton	Bales	331, 998	$13, 505, 161
Guano	Tons	650	34, 828	Coal	Tons	40, 836	115, 147
Kainit	do	802	4, 382	Staves	Number	4, 531, 079	234, 825
Cocoa-nuts	Number	92, 000	2, 760	Wheat	Bushels	111, 355	107, 064
Coal	Tons	292	689	Corn	do	108, 756	56, 778
Scrap iron	Pounds	51, 520	230	Flour	Barrels	8, 310	45, 040
Personal effects			731	Tobacco	Pounds	2, 290, 527	116, 599
Potatoes	Bushels	2, 809	476	Logs	Pieces	2, 934	38, 862
Wine	Gallons	286	187	Bark	Pounds	1, 048, 059	13, 607
Whisky	do	36½	49	Plank	Pieces	10, 771	10, 807
Kid gloves	Dozen	2	14	Hard woods			13, 066
Miscellaneous			3, 014	Lumber			23, 360
				Shingles	Number	240, 000	1, 600
				Miscellaneous			2, 033
				Bagging of foreign manufacture.	Yards	1, 601, 296	109, 893
Total			99, 958	Total			14, 393, 337

Direction.	Vessels cleared.		Vessels entered.	
	No.	*Tons.*	*No.*	*Tons.*
Foreign	208	207, 428	73	73, 896
Coastwise	1, 719	1, 432, 016	1, 432	1, 261, 365
Total	1, 927	1, 639, 444	1, 505	1, 335, 261

Abstract of proposals received for furnishing, building, and delivering a steam-tender, opened by Capt. F. A. Hinman, Corps of Engineers, at Norfolk, Va., September 14, 1886.

No.	Names and addresses of bidders.	Price.
1	Henry Brusstar and William S. Brusstar, Baltimore, Md	$11, 362
2	E. J. Codd & Co., Baltimore, Md	10, 900
3	John C. Froehlich & Co., Baltimore, Md	12, 750
4	H. A. Ramsay & Son, Baltimore, Md	13, 000
5	C. Reeder & Sons, Baltimore, Md	11, 845

Contract with E. J. Codd & Co.

Abstract of proposals received for dredging to improve the southern branch of Norfolk Harbor, Virginia, and the approach to said harbor, between Lambert's Point and Fort Norfolk, opened by Capt. F. A. Hinman, Corps of Engineers, Norfolk, Va., November 11, 1886.

No.	Names and addresses of bidders.	Stipulations.	Capacity, (cubic yards per day).	Price per cubic yard.	
				Material dredged from southern branch.	Material dredged from approach to harbor.
				Cents.	*Cents.*
1	P. Sanford Ross, Jersey City, N. J.	Commence work within twenty days after award of contract and complete same within time specified, two or more clam-shell dredges.	4,000	16	13.2
2	Morris & Cumings Dredging Company, by Joseph Cumings, president, New York, N. Y.	Commence work within twenty days from time of signing contract, two or more clam-shell machines.	4,000	15.5	13
3	George C. Fobes & Co., Baltimore, Md.	Commence work about December 10, and complete by June 15, 1887, two or more grapple dredges and appliances.	3,000 to 4,000	17	13
4	National Dredging Company, by George G. Barker, treasurer, Wilmington, Del.	According to specifications, two or more grapple dredges.		15.9	13
5	Byron Clark Howell, New York, N. Y.	Commence work with propeller *Howard* within twenty days from signing contract, and with propeller *Bolivar* by or before December 20, 1886. Two hydraulic dredging propellers.	*1,500 †3,000	§23.5 ‖17.5	§18 ‖14.5
6	John A. Benson and John H. McNee, Washington, D. C.	Commence work within twenty days from date of contract. One Von Schmidt patent dredge.	‡4,000	‖19.5	‖21

* For *Howard*.
† For *Bolivar*.
‡ Not less than, per day of 24 hours.
§ Measured in scows.
‖ Measured in place.

Contract with Morris & Cumings Dredging Company.

Abstracts of proposals received for furnishing district supplies, opened by Capt. F. A. Hinman, Corps of Engineers, at Norfolk, Va., December 8, 1886.

No.	Names and addresses of bidders.	Amount of bid for articles to be delivered in Norfolk, Va.			Amount of bid for articles to be delivered in Petersburgh, Va.	
		Class 1 (fuel and water).	Class 2 (hardware, ship-chandlery, and miscellany).	Class 3 (stationery and drawing materials).	Class 4 (fuel).	Class 5 (hardware, ship-chandlery, and miscellany).
1	E. V. White & Co., Norfolk, Va		$1,228.12			
2	Hume & Parker, Norfolk, Va			$302.97		
3	J. Vickery, Baltimore, Md.; Jno. James Samuel, Norfolk, Va.; Richard J. Alfriend, Norfolk, Va.			306.20		
4	Elliott & Walke, Norfolk, Va		1,207.00			
5	Mayer & Co., Norfolk, Va		1,299.90			*$194.39
6	Robert Johnston, Norfolk, Va			*280.25		
7	Geo. W. Taylor & Co., Norfolk, Va	*$399.50				
8	E. J. Griffith & Co., Norfolk, Va		*1,198.58			200.56

* Accepted.

L 2.

IMPROVEMENT OF APPROACH TO NORFOLK HARBOR AND THE UNITED STATES (NORFOLK) NAVY-YARD BETWEEN LAMBERT'S POINT AND FORT NORFOLK, VIRGINIA.

The act of August 5, 1886, appropriated $137,500 for this work, to be expended "in widening the channel of Elizabeth River to the port-warden's line on the eastern side, between Lambert's Point and Fort Norfolk, beginning at Lambert's Point Light, including the construction of the proposed dike."

A project (copy herewith) for the expenditure thereof was submitted to the Chief of Engineers and duly approved.

In accordance therewith, on October 12, 1886, proposals were invited for dredging in the vicinity of Lambert's Point Light, and on November 22, 1886, a contract was entered into with the Morris & Cumings Dredging Company, of New York City, the lowest bidder according to the specifications, to do the work at 13 cents per cubic yard, measured in scows.

The company began work December 13, 1886, and completed it February 15, 1887, having removed 179,992 cubic yards of material strictly in accordance with the terms of the contract.

This work resulted in a channel at least 25 feet deep and not less than 600 feet wide at mean low water, from the main ship-channel to Lambert's Point Coal Pier—about 1,000 feet.

Soon after the completion of the dredging, and as a proper precaution before commencing the proposed dike, the entire reach was resurveyed and a map of same made (copy herewith). This showed that there was a straight channel through it at least 25 feet deep and not less than 450 feet wide at mean low water, which had improved since it was dredged in 1885 and seemed to be self-sustaining. The officer in charge, on April 18, 1887, reported accordingly to the Chief of Engineers, recommending that the construction of the dike be indefinitely postponed, and that the money therefor be applied to additional dredging. On April 29, 1887, the matter was referred by the Chief of Engineers to a Board of Engineer Officers, who submitted a report thereon dated May 11, 1887. On June 11, 1887, the Chief of Engineers submitted the question, with his views, to the honorable the Secretary of War, who directed, on June 15, 1887, as follows:

> The money reserved for the dike will be held until the proper position of the dike can be determined, and the whole subject will be submitted to Congress at its next session.

In accordance therewith, copies of all the papers relative to the foregoing are appended hereto.

It is understood that another buoy will be placed, in due time, on the straight easterly side of the dredged channel, making three, in a straight line to mark it.

The steam-tender *Lucerne* was built for use on this and other works. For the details relative thereto, and also for commercial statistics and abstracts of proposals, see report for this fiscal year on harbor at Norfolk and its approaches, of which this is a part.

The sum of $118,100 can be profitably expended in the fiscal year ending June 30, 1889, with which it is proposed to complete the improvement as projected, to the great benefit of navigation, commerce, and the United States (Norfolk) navy-yard.

Norfork is a port of entry.

Money statement.

July 1, 1886, amount available	$2,850.
Amount appropriated by act approved August 5, 1886	137,500.
	140,350.
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	32,348.
July 1, 1887, amount available	108,001.
Amount (estimated) required for completion of existing project	118,100.
Amount that can be profitably expended in fiscal year ending June 30, 1889	118,100.

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

SPECIAL REPORT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEER

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., April 18, 1887.

GENERAL: I have the honor to report as follows relative to the i
provement of the approach to Norfolk Harbor between Lambert's Poi
and Fort Norfolk, Virginia. Reference herein is made to the acco
panying comparative map* of my two surveys of this locality, made
1884 and 1887, respectively.

The river and harbor act of July 5, 1884, provides as follows:

> Improving approach to Norfolk Harbor and the United States (Norfolk) navy-yar
> Continuing improvement, the widening of the channel of the Elizabeth River, b
> tween Lambert's Point and Fort Norfolk, $50,000.

A Board of Engineer Officers was convened in August, 1884, to pr
pare a project for the application of this appropriation. On Septemb
3, 1884, the Board made a preliminary report on this matter, and on O
tober 29, 1884, a final report (copies of both herewith).†

The following is quoted from the final report of the Board:

> The Board invites attention to the fact that the long pier lately built by the Norfo
> and Western Railroad Company, terminating at the Lambert's Point Light, is real
> a jetty or dike, and repeats the statement of the preliminary report of September
> relative thereto, viz:
>
> "This doubtless has produced changes in the tides, and changes in the channel m
> be expected to follow."
>
> The Board is of the opinion that the channel between Lambert's Point and F
> Norfolk would be much improved by the construction of a dike beginning at or ne
> Pinner Point, and carried in a direction parallel to the branch of the port-warde
> line on the east side of the river, its length to be about 1 mile and its heighth abo
> the level of high water. The full benefit of this dike cannot be realized, it is thoug
> until the said branch of the port-warden's line, now existing only on paper, becom
> a real line in the place assigned it. It is important also to note that the effect of t
> only dredging done in this locality between 1878 and 1880, no dike being in existenc
> has failed to be permanent, and it may be confidently expected that a dredged cha
> nel cannot be maintained there without occasional dredging until after the constru
> tion of the Pinner Point Dike. While the Board advocates this dike, it has doub
> under the specific phraseology of the law, whether the whole or any part of the appr
> priation under consideration can be applied to its construction at this time. Howeve
> were this now applicable to the dike it would seem best to refrain from building
> until time has shown the full effects of the Lambert's Point Dike. In view of the unce
> tainties of the situation, the considerable time—six weeks or two months—before wo
> could properly be now commenced with the present appropriation, the fact that Co
> gress will soon again be in session and that the session will be a short one, it seems
> the Board most judicious to refrain from expending the present appropriation un
> Congress can be further consulted, unless the money be applied to dredging in t

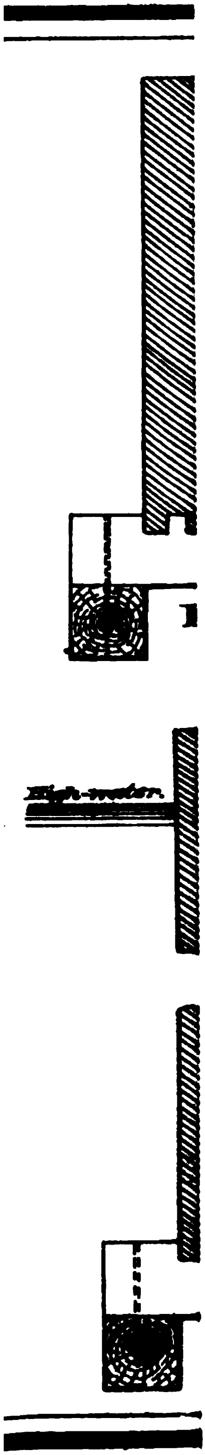
---

* Omitted.

† Omitted. Printed in Report of Chief of Engineers, 1885.

1

3



narrowest and shoalest parts of the channel. But the permanence of such dredging cannot be considered as assured until the dike from Pinner Point be built.

However [to quote from page 150, Report of the Chief of Engineers, U. S. Army, 1886], the requirements of navigation demanding the widening of the channel as contemplated in the project already commenced and partly executed, by dredging, it was recommended that the existing appropriation be applied to widening the channel between Lambert's Point and Fort Norfolk by dredging along the eastern side thereof. This having been approved, the work was done accordingly.

There was expended in the fiscal year ending June 30, 1886, $46,806.89, which was applied to the removal of 469,944 cubic yards of material, measured in scows, resulting in a straight channel not less than 25 feet deep, and at least 400 feet wide at mean low water the entire length of this approach. Formerly the channel had an angle in it. This work has materially benefited navigation and commerce. The easterly side of the channel should be buoyed every 1,200 feet to mark it properly.

The area dredged is accurately located on the map.

The river and harbor act of August 5, 1886, provides as follows:

> Improving harbor at Norfolk, Va., and improving approach to Norfolk Harbor and the United States navy-yard at Norfolk. Continuing improvement by widening the hannel of Elizabeth River to the port-warden's line on the eastern side, between ambert's Point Light and Fort Norfolk, $187,500, of which $50,000 shall be expended n improving the harbor, and $137,500 in widening the channel of Elizabeth River to the port-warden's line on the eastern side between Lambert's Point Light and Fort Norolk, beginning at Lambert's Point Light, including the construction of the proposed ike.

On August 16, 1886, I submitted a project for the expenditure of this sum, from which I extract the following:

> As no "project with estimate of cost" has ever been furnished to my knowledge, for "widening the channel of Elizabeth River to the port-warden's line on the eastern side, between Lambert's Point Light and Fort Norfolk," I respectfully submit he following, (see accompanying map* of the locality in question): The proposed port-warden's line represented thereon has received your approval (see page 155, Report of the Chief of Engineers, 1885), but it has not yet been adopted by the Board of Harbor Commissioners of Norfolk and Portsmouth, Va. I have spoken to members of the Board about it but they are slow to act, seemingly. However, it is probable that the Board will adopt it.
>
> In my project of June 30, 1885, found on page 1026, Report of the Chief of Engineers, 1885, I estimated for dredging a channel between Lambert's Point and Fort Norfolk, 25 feet deep at ordinary low water; the area to be dredged is shaded on the accompanying map.* The estimate was 680,000 cubic yards (in round numbers), measured in place, at 22 cents, $149,600. To dredge the balance to the proposed port-warden's line would require the removal of 930,000 more cubic yards (in round numbers) of material, measured in place, at 22 cents, $204,600. To dredge to the port-warden's line (between it and the proposed port-warden's line) would require the additional removal of 1,870,000 cubic yards (in round numbers) of material, measured in place, at 22 cents, $411,400.
>
> * * * * * * *
>
> The plan and project now in process of execution for the approach to this harbor, between Lambert's Point and Fort Norfolk, is:
>
> 1. To secure a channel, not less than 25 feet deep and 500 feet wide at ordinary low water, from Lambert's Point to Fort Norfolk, by the construction of a dike and by dredging, and
> 2. To ultimately widen this channel to within 75 feet of a straight line drawn from Fort Norfolk to the deep water opposite Lambert's Point, 6,800 feet of which is the proposed port-warden's line, making the channel at least 700 feet wide.
>
> All the work done to date has resulted in a straight channel (mainly dredged last fall) in the approach to the harbor from Lambert's Point to Fort Norfolk, 25 feet deep and not less than 400 feet wide at mean low water.
>
> * * * * * * *
>
> It is proposed to expend the aforesaid amount as follows:
>
> * * * * * * *
>
> *Approach to Norfolk Harbor.*—(1) *Dredging.*—It is proposed to expend $25,000 in dredging here. The language of the act is specific and mandatory, in fact a project to which only details can be added.

---

*Omitted.

It is understood that last year the Norfolk and Western Railroad Company dredged an approach to its pier at Lambert's Point, 22 feet deep and gradually widening from the pier-head out to the channel. It is now proposed simply to deepen and widen this approach on the southerly side.

Reference herein is made to the accompanying map* of the last survey of this locality, made in 1884.

The prolongation of a line bisecting the angle made by the port-warden's lines at Lambert's Point Light will be the northern boundary of the area to be dredged. It is proposed to begin at the 25-foot channel end of this line and dredge along it into the port-warden's line, and continue in a like manner parallel to this line as far south as the funds will permit, making the whole area dredged not less than 25 feet deep at mean low water.

(2) *Pinner Point Dike.*—It is proposed to construct the dike along the line marked "proposed dike" on the accompanying map.* The sectional area between this line and the "proposed port-warden's line," after dredging as proposed, will equal the *natural* sectional area at Fort Norfolk. The short arm of the dike will be 1,000 feet long and the other arm 4,000 feet. Borings show that the bottom for the first 1,575 feet from the shore is hard and the balance soft.

It is recommended that the short arm be constructed of stone, sand, and brush; that the next 575 feet be built of concrete, as per my inclosed plan, and the balance of creosoted piles, with stone and brush filling. (Detailed specifications for a dike of this description were submitted to you February 23, 1885.) The estimated cost of this dike is $106,000, as stated in my annual report, page 1026, Report of the Chief of Engineers, 1885.

RECAPITULATION.

Dredging at Lambert's Point	$25,000
Proposed dike	106,000
	131,000
Appropriated by act of August 5, 1886	137,500
Balance	6,500

It is respectfully recommended that all the foregoing be done by contract, after advertising thirty days for proposals, it being most economical and advantageous to the Government to do so, and that the balance be held for contingencies.

(The said Board of Harbor Commissioners unanimously adopted the said "proposed port-warden's line" on October 13, 1886.)

This project was approved by you on September 28, 1886, subject to the suggestion of the Board of Engineers, "that the experiment with the concrete pier be tried on a small scale until its value and economy be ascertained."

The dredging proposed in the project has been duly executed. It was commenced December 13, 1886, and completed February 15, 1887; 179,992 cubic yards of material, measured in scows, was removed, making a channel at least 25 feet deep and not less than 600 wide at mean low water, from the main channel to the port-warden's line, a distance of about 1,000 feet.

On completion of this dredging I made a resurvey and map* of the locality in question last month, deeming it wise to do so before commencing the dike.

The area dredged from 1878 to 1880 under the direction of my predecessor is not shown on the map, as it cannot be located accurately, only one point of reference being known.

A careful examination of this map shows that there exists a straight channel, not less than 25 feet deep and at least 450 feet wide at mean low water, from Lambert's Point to Fort Norfolk. The portion dredged fifteen months ago has fully maintained itself, in fact widened about 50 feet, and no material change has occurred in the balance of the bed of water area under consideration, except in the vicinities of Fort Norfolk and Lambert's Point, respectively, where the 30-foot curves do not coincide, as do virtually the other similar curves. The depth has increased about 3 feet at the former place and decreased correspondingly at the latter. The dredged channel of 1878–'80 shoaled opposite Pinner Point before the construction of the Lambert's Point Dike, but since the construction of this dike in 1884 that portion of the shoal not dredged in 1885 has disappeared.

---

*Omitted.

The foregoing shows that the Lambert's Point Dike has "produced changes in the channel," to use the Board's language, that are favorable to it. Possibly the "full effects" have not yet been obtained, as sufficient time has not elapsed. It seems fair to assume, however, that this improvement will be permanent without the aid of the dike proposed at Pinner Point, and that the channel will improve more when the port-warden's line, "now existing only on paper, becomes a real line in the place assigned it."

It is therefore recommended that the construction of this dike be postponed indefinitely, and that the balance of the appropriation, $108,000, be applied to dredging, which, under the law, should be in continuation of that commenced at Lambert's Point, but from an engineering point of view in continuation of that done in 1885. In fact, the last river and harbor bill, which did not receive the President's approval, admitted of this, as the item for this work read, "widening the channel of the Elizabeth River *toward* the port-warden's line," instead of "*to* the port-warden's line."

It is estimated that with the funds available an area of 48 acres, shaded blue on the map, can be dredged, being 613,400 cubic yards, measured in place, at 17 cents, $104,278; the balance, $3,722, being held for contingencies.

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. William P. Craighill, Corps of Engineers.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., April 20, 1887.

Respectfully forwarded to the Chief of Engineers.

It is doubtful whether, under the wording of the appropriation of August 5, 1886, the dike can be ignored and the money all devoted to dredging, as proposed by Captain Hinman. Expression of opinion as to other points does not seem necessary until that question be disposed of, which is one of law.

The views of the Board quoted on page 2 of Captain Hinman's report are worthy of careful consideration. They indicate a belief that while important results may be expected from the construction of the dike from Pinner's Point, delay in that work might be judicious, until time had shown the effects of the jetty at Lambert's Point. Further delay might result in a better location for the "proposed dike" than that now adopted.

It might be deemed expedient to at once construct the *spur* projecting from Pinner's Point, which is a necessary part of the dike, but to defer the branch parallel to the port-warden's line, as that line may be again changed, inasmuch as there is nothing now fixing it on the location assigned to it, and a change is, in fact, not improbable. If this view were adopted a large part of the balance of the appropriation of

1886 could be devoted to dredging, while complying with the law. On the whole, it is recommended that the subject be referred to the Board of 1884 for consideration and report.

WM. P. CRAIGHILL,
Colonel of Engineers.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 25, 1887.

Respectfully submitted to the Secretary of War, inviting attention to the foregoing indorsement by Col. W. P. Craighill, Corps of Engineers.

His recommendation that the subject be referred to the Board of Engineers who considered it in 1884 is concurred in.

The Board consisted of the following officers of the Corps of Engineers: Col. W. P. Craighill, Lieut. Col. P. C. Hains, and Capt. F. A. Hinman; and if approved by the Secretary, it will be re-convened by orders from this office, to meet at Norfolk, Va., upon the call of the senior member, and at such time as the other duties of the members will permit, to consider and report upon the questions now presented.

The expenses of the Board to be paid by Captain Hinman from the appropriation for improving Norfolk Harbor, Virginia.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT,
April 27, 1887.

Approved as recommended by the Chief of Engineers.

By order of the Acting Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., May 11, 1887.

GENERAL: The Board of Officers of the Corps of Engineers, composed of the undersigned, constituted by Special Orders, Nos. 110 and 135, Headquarters Corps of Engineers, series of 1884, and reconvened by Special Order No. 57, Headquarters Corps of Engineers, current series, reassembled in this city to-day pursuant to the foregoing. The Board duly considered all the matters referred to it for action relative to the improvement of Norfolk Harbor, Virginia, and respectfully submits the following report thereon:

The Board is of the opinion that the proposed dike at Pinner Point should not be built until the port-warden's line from Lambert's Point to Fort Norfolk becomes an actuality, which is not now the case. It is probable that some years will elapse before many structures will be built out to the port-warden's line. This line has been changed several times by the State Board of Harbor Commissioners—once in October last—since the passage of the river and harbor act of August 5, 1886. The location of the dike depends so largely on that of the port-warden's line, that the Board feels compelled to recommend that its construction be delayed at least until some of the proposed docks between Lambert's Point and Fort Norfolk be built out to the port-warden's line. The dike is not imperative now, as the channel is in excellent condition.

The question arises, what shall be done with the funds available? Shall this amount be held indefinitely for the construction of the dike, or shall it be applied to dredging? If additional dredging be done, shall it be in extension of that commenced at Lambert's Point or in continuation of that done in 1885, namely, in widening the narrowest part of the existing channel? The latter would seem to be the most reasonable course from an engineering or common sense view.

This Board is decidedly of the opinion that to do the former would be in accordance with the law, as stated by Captain Hinman, but it agrees with him that it should be at the latter place. However, before further action be taken, the Board recommends that this matter be referred to the proper authority for opinion as to whether the money now available may be applied to dredging alone, and, if so, can it be applied to widening the channel in its narrowest part?

Your letter of the 29th ultimo and the papers referred to therein are returned herewith, as directed. It is respectfully recommended that they be appended hereto.

Very respectfully, your obedient servants,

WM. P. CRAIGHILL,
Colonel of Engineers.
PETER C. HAINS,
Lieut. Col. of Engineers.
F. A. HINMAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 11, 1887.

Respectfully submitted to the Secretary of War.

The within report of the Board of Engineers, convened by direction of the Secretary of War, by Special Orders, Headquarters Corps of Engineers, dated April 29, 1887, to consider certain questions in reference to the expenditure of the appropriation made by the river and harbor act of August 5, 1886, for improving harbor at Norfolk, Va., as suggested in the accompanying project of Capt. F. A. Hinman, Corps of Engineers, coincides in opinion with that officer as to the *best* mode of applying it, but suggests the question whether, under the peculiar wording of the law, the amount reserved for the dike can be properly applied to dredging. In a communication upon the subject from Col. W. P. Craighill, Corps of Engineers, the senior member of the Board, dated the 6th instant, herewith, to which reference is respectfully invited, he argues that while the dike is a *part* of the approved plan its construction from one appropriation is no more necessary than is all the dredging required in the whole scheme of improvement. It may be added in this connection that the location of the dike in question cannot at this time be properly determined, and until its location is finally decided upon its construction cannot be commenced.

The question therefore becomes, must this money be held for the construction of the dike, whose proper location at this time can not be decided upon, or may it be expended in the dredging contemplated in the project that has been approved by Congress? It is submitted that the act of August 5, 1886, making appropriation for Norfolk Harbor, does not modify the project, but in its strictest construction can only be interpreted as specifying the method of prosecuting it. If this view of the case be concurred in and in the opinion of the Secretary of War all the money in question can be used in dredging, it is recommended that the channel be increased in width "on eastern side, between Lambert's Point Light and Fort Norfolk."

Should, however, the Secretary of War decide that the money reserved for the dike must be expended in its construction, it is recommended that on account of the difficulty in deciding upon the proper location for it that the money be held until such a time as its proper position can be determined, and that in the mean time the question be submitted for future action of Congress.

CHAS. W. RAYMOND,
Acting Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *June* 15, 1887.

Respectfully returned to the Chief of Engineers.

The money reserved for the dike will be held until the proper position of the dike can be determined, and the whole subject will be submitted to Congress at its next session.

By order of the Acting Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

LETTER OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, SENIOR MEMBER OF THE BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., June 6, 1887.

GENERAL: While I have signed the unanimous report of the Board of Engineers, dated May 11, concerning the improvement of Norfolk Harbor, Virginia, which contains all the matter essential to be considered from an engineering point of view, it seems expedient to invite attention to several other features of the situation that may otherwise escape notice.

The cause of the apparent delay in the rendition of the report is explained in another letter of this date.

The total appropriation of August 5, 1886, was $187,500. The words of the law are as follows:

> Improving harbor at Norfolk, Va., and improving approach to Norfolk Harbor and the United States navy-yard at Norfolk; continuing improvement by widening the channel of Elizabeth River to the port-warden's line on the eastern side, between Lambert's Point Light and Fort Norfolk, one hundred and eighty-seven thousand five hundred dollars, of which fifty thousand dollars shall be expended in improving the harbor, and one hundred and thirty-seven thousand five hundred dollars in widening the channel of Elizabeth River to the port-warden's line, on the eastern side, between Lambert's Point Light and Fort Norfolk, beginning at Lambert's Point Light, including the construction of the proposed dike.

This language is peculiar, as it defined specifically the location of the dredging, confining it to the vicinity of a certain property at Lambert's Point, though the Board of Engineers, in their report of October 29, 1884, had made an entirely different recommendation, embodying a proposition which seemed to provide for the general good rather than for any particular interest, however important that interest might be to its owners, or to the city of Norfolk and its commerce.

But the law was imperative, and was strictly complied with as far as the dredging was concerned.

Enough money was reserved for the construction of the dike mentioned in the law. The dike has not yet been built, and this delay is in conformity to the opinion of the Board as expressed in its report of October, 1884, after which, viz, August 5, 1886, Congress made the appropriation of that year.

The Board is of the opinion that further delay in the construction of the dike is still expedient.

The question arises, can this reserved money be spent in whole or in part for dredging, or must it be applied entirely to the dike?

The improvement of Norfolk Harbor is a *continuing* work; that is, one which has been approved by Congress, is now in progress, and has been the subject of appropriation more than once. The dike is *a part* of the approved project. Its construction from one appropriation is no more necessary than is all the dredging required in the whole scheme of improvement.

For these reasons it would seem admissible to omit, for the present, the application to the dike of any part of the funds now available, and to use them in dredging.

As the harbor now is in reasonably good condition, and the location for additional dredging required by law seems clearly not the best, it would, perhaps, be wisest to do nothing either in the construction of the dike or in more dredging until the whole subject can be again considered by Congress at the next session.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L 3.

IMPROVEMENT OF ARCHER'S HOPE RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1887. It was deemed inexpedient to resume them, the funds available being insufficient.

The amount that can be profitably expended in the fiscal year ending June 30, 1889, is $9,400.70. This will be applied to dredging and will complete the project.

This is an insignificant stream and no improvement to speak of has been effected thus far. If there be any commercial statistics they are too unimportant to be considered. None could be obtained.

This work is in the collection district of Yorktown, Va.

Money statement.

July 1, 1886, amount available	$20.63
July 1, 1887, amount available	20.63

Amount (estimated) required for completion of existing project	$9,400.70
Amount that can be profitably expended in fiscal year ending June 30, 1889.	9,400.70
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

L 4.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

The act of August 5, 1886, appropriated $18,750 for this work. A project for the expenditure thereof was submitted, on August 14, 1886, to the Chief of Engineers and duly approved. The following was done in accordance therewith:

In order to ascertain the condition and wants of the river and to work intelligently and systematically thereon, that portion from the head of navigation at Petersburg to the natural deep water at Point of Rocks below, 7⅝ miles, was resurveyed, September 11 to 24, 1886, by Mr. H. J. Gielow, assistant engineer, and a map of same made. A copy of the map, consisting of 1 general and 8 detailed sheets, is transmitted herewith. There is shown thereon what has been done since the survey, and also what is proposed for the future, to obtain and maintain a channel at least 12 feet deep and not less than 100 feet wide on the bottom at mean high tide. Recent data shows that such a channel can be had whereas before the width was rather indefinite.

The late deterioration of the channel, referred to below, called for a revision of the project, which has been made accordingly. The means to accomplish it are similar to those used heretofore and the cost only $6,560 in excess of the original project. The details of this are set forth in the accompanying report, dated the 13th ultimo, of Mr. H. J. Gielow, assistant engineer, which is based on the latest data and meets with my approval.

His estimate for this is as follows:

Dredging 54,250 cubic yards sand, measured in place, at 30 cents	$16,275
Constructing 3,930 linear feet of training-walls and jetties, at $2.50	9,825
Constructing 1,000 linear feet of revetment, at $2	2,000
Repairing old jetties	1,300
	29,400
For engineering and contingencies, 15 per cent	4,410
	33,810

The estimate for improving "Stein's Upper Cut" is $71,400 as set forth in report of Capt. Thomas Turtle, Corps of Engineers, page 904, Report of the Chief of Engineers, 1882. His estimate for "diverting the water of the river above the harbor at Petersburg to the old north channel" is $105,223.33, as stated in his report on page 907 of the foregoing.

The navigable channel of this river was in quite a satisfactory condition up to July last, when an extraordinary freshet occurred that injured it somewhat; it was the highest that has been since that of 1851, which was 1 foot higher. As soon thereafter as funds were available and a proper survey could be made, dredging was commenced through the three shoals that were largely due to the freshet, and although the days (from October 14 to April 30) were short and the weather very unfavorable, the channel was nearly if not fully restored to its former condition. In January the river was frozen over many days; there were but ten fair working days during the month. It is thought that the measures taken will guard against this calamity in future. On the 11th ultimo a schooner drawing 11 feet passed up to Petersburg on a very high tide. On the 4th ultimo three lines of longitudinal soundings were made simultaneously under my personal direction, between Petersburg and Point of Rocks, one from the bow of the tow-boat and the other two from skiffs fastened amidships, 25 feet apart. They were taken as fast as the sounding rods could be used, the boat moving slowly. These soundings show a navigable channel at least 10.5 feet deep at mean high tide. The shoalest places are just above Gatling's Landing and at Sunken Island. It is thought that the recent closing of Old Channel above the former at two points—the mattress dam, a continuation of the closure dike, and Rushmore's Dam, near the foot of Puddledock Cut—will have a tendency to scour out and maintain the channel above Gatling's Landing.

The seven temporary revetments along Puddledock Cut have well subserved their purpose to hold up the dredge bank for the time being, and will not be considered hereafter. Besides these there is now an aggregate of seventy-seven structures to be maintained in this river, *i. e.*, 1 revetment, 67 jetties, 3 dams, and 6 training-walls. Of these, 35 jetties and 1 training-wall are in Petersburg Harbor, which is under the jurisdiction of the city of Petersburg. Some of the latter are not in good order. The balance are in fair condition. It is proposed to build 9 more structures, *i. e.*, 7 jetties and 2 training-walls in the south channel.

The city has dredged and is now dredging the harbor, and has dumped material behind Lieutenant Run wall (very dilapidated) and Poor Run Dike from these structures to the shore. It is understood that the city will provide for any deterioration of the channel that may ensue therefrom.

On August 20, 1886, proposals were invited for a new steam-boiler to replace the condemned one on the tow-boat. Those received in response thereto were opened September 20, 1886, and a contract duly made on September 27, 1886, with the West Point Engine and Machine Company, of West Point, Pa., to deliver the same at Petersburg, Va., on November 11, 1886. The contractors did not deliver it as agreed, and after the expiration of the contract they made application for an extension of the time for delivery, which was not granted. However, the boiler was accepted, as it was for the interest of the Government to do so. It was delivered on December 15, 1886, and placed in position on the tow-boat by the hire of labor and the purchase of materials in open market, so that the boat was in commission on January 2, 1887. This boat and the pile driver were hauled out during the year, calked, and put in good order.

Two fine deck scows, each with a capacity of 50 cubic yards, were built by hired labor and the purchase of materials in open market, and by contract, at a cost of $1,650.

By the hire of labor, the dredge and two scows belonging to the city of Petersburg, and a tug, replaced by the Government tow-boat as soon as in commission, 25,047 cubic yards of material, measured in scows, was dredged, as under, in the order named, that being the most urgent. All cuts were 20 feet wide and 12 feet deep at mean high tide; 4,608 cubic yards from the shoal at Gatling's, where one cut was made through it 1,775 feet in length. War projectiles were dug up here, showing that the shoal was not of recent date, 14,859 cubic yards from the shoal at the head of Puddledock Cut, where two cuts were made through it 2,340 feet long. This sand-shoal was largely due to the erosion of the dredged material on the left bank, where the river makes a turn into Puddledock Cut; 5,580 cubic yards were removed from Rushmore's Shoal at the foot of Puddledock Cut. Two cuts and about half of a third were made through this 774 feet long. This channel is now straighter than formerly. It is thought that it had never before been completed, as not only sand but gravel and very stiff clay were encountered.

By hired labor, the purchase of materials by contract and in open market, the use of brush cut on the reservation along Puddledock Cut, and the aid of the Government plant, the following was done:

A break of 78 linear feet in the upper (old) portion of Poor Run Dike was repaired.

Jetties 11 and 12, in Petersburg Channel, were cut off 10 and 20 feet, respectively, to make the channel near them of uniform width and cross-section. Minor repairs were made to other jetties in their vicinity.

Joiner's Spring Dike was repaired at both ends to give it strong shore connections.

The "mattress dam," 137 feet long, an extension of the closure dike and Jetty 21, was strengthened and raised to correspond with the latter to prevent the flow of the ebb tide into "Old Channel" at mean high tide. This required considerable work.

Extensive repairs were made to 480 linear feet of the old portion of the closure dike, such as new log and sheet piles, braces, cap and wale pieces, here and there, additional brush and gravel protection along it to prevent scour, etc.

A pile and fascine revetment 348 feet in length was built along the left bank at the upper end of Puddledock Cut to check erosion where the river turns into the same.

The break, 104 linear feet, in Rushmore's old dam was closed, as observation showed that at nearly all stages of the tide there was a flow through it from the foot of Puddledock Cut into Old Channel that caused the navigable channel to deteriorate. This also turns more water into Gatling's Reach to assist in maintaining the channel therein.

The construction of Rushmore's log and sheet pile dike, 607 feet long, was commenced and nearly completed. The object of this is to assist in maintaining the channel through Rushmore's Reach.

The old dam across the northerly channel at Sunken Island having nearly disappeared, the construction of a new log and sheet pile dam 276 feet long was begun for the betterment of the other channel. It has been located about 75 feet below the old one in order to facilitate its construction.

The small balance available will be applied to the care of property and contingencies. The sum of $33,810 can be profitably expended in the fiscal year ending June 30, 1889, with which it is proposed to complete the improvement as projected, to the great benefit of navigation and commerce. It is estimated that $5,000 will be required yearly thereafter to maintain the work, parts of which are of a perishable nature and will need repairs.

The annual report of J. H. Van Auken, president Lower Appomattox Company, and the commercial statistics are appended hereto.

Petersburg is a port of entry.

Money statement.

July 1, 1886, amount available		$857.30
Amount received from an officer for fuel		45.00
Amount appropriated by act approved August 5, 1886		18,750.00
		19,652.30
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$18,510.81	
July 1, 1887, outstanding liabilities	318.72	
		18,829.53
July 1, 1887, amount available		822.77
Amount (estimated) required for completion of existing project		33,810.00
Amount that can be profitably expended in fiscal year ending June 30, 1889.		33,810.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for furnishing, building, and delivering a steam boiler, opened by Capt. F. A. Hinman, Corps of Engineers, at Norfolk, Va., September 20, 1886.

No.	Names and addresses of bidders.	Price.
1	John C. Froehlich & Co., Baltimore, Md	$730.00
2	Henry Warden, Philadelphia, Pa	750.00
3	Theodore Smith and Henry Smith, Jersey City, N. J	695.00
4	H. T. Morrison, Petersburg, Va	583.80
5	S. C. Forsaith Machine Company, by W. E. Drew, agent, Manchester, N. H	614.00
6	E. J. Codd & Co., Baltimore, Md	1,042.00
7	West Point Engine and Machine Company, West Point, Pa	495.00

Contract with West Point Engine and Machine Company.

PROJECT OF MR. H. J. GIELOW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., June 13, 1887.

CAPTAIN: In compliance with your verbal instructions I have the honor to submit herewith an estimate for the attainment and maintenance of a channel 100 feet wide and 12 feet deep at mean high tide in the Appomattox River, Virginia, from the city of Petersburg to Point of Rocks.

HARBOR OF PETERSBURG.

The improvement of this part of the river, including the scheme of opening Stein's Upper Cut, comes under the domain of the city of Petersburg, and, with the exception of the river and harbor act dated March 3, 1881, does not seem to have been contemplated by river and harbor acts; therefore no estimates have been made for this part of the river.

PETERSBURG CHANNEL.

It is thought that in this reach the desired channel (12 feet by 100 feet cross-section) can be obtained by jetties alone, but the commercial interests involved seem to require immediate relief by dredging rather than the much slower process of erosion by the jetty system. For this reason it is recommended that the channel, in the vicinity of Hare's Dike and above, be dredged to the required width and depth, and that the jetties be relied on for maintaining it.

Jetties Nos. 5 to 14, inclusive, are spaced 300 feet apart. This distance appears to be too great and should be reduced to about 225 feet by constructing 75-foot sections of training wall, up stream, from the channel ends of Jetties 8, 9, 10, 11, 12, and 13. The brush portion of Jetty No. 5 should be repaired, as the bad condition of this jetty is responsible for the shoaling in the western edge of channel between Jetties 5 and 6. General repairs are needed on Jetties 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 20.

The cost of this improvement is estimated as follows:

Dredging 4,350 cubic yards sand measured in place, at 30 cents	$1,305
Constructing six sections of training-wall, 75 linear feet each, 450 feet, at $2.50	1,125
Repairs to old jetties	1,300
	3,730

PUDDLEDOCK CUT.

A bar or a shoal commencing between Jetties 20 and 21 and extending 3,000 feet down-stream, has formed since the dredging in 1885. The cause for this was two-fold: (1) A large volume of water passed through into the old channel, resulting in a considerable reduction in the velocity of the current in the locality in question and causing a deposit of matter held in suspension by the water, which was (2) augmented by the caving of the west bank in this vicinity. The causes have been removed, (1) by the completion of the closure dike, the whole volume of water now passing through Puddledock Cut, producing a more uniform current with an increased velocity, and (2) 348 linear feet of revetment has been constructed immediately below the closure dike to protect the west bank. It is proposed to extend this 1,000 feet farther ultimately, if required. Two cuts have been dredged through this bar, resulting in a channel 40 feet wide and 12 feet deep at mean high tide. The remainder of this bar should be removed by dredging as soon as funds will permit.

The main portion of Puddledock Cut is in excellent condition, having a channel not less than 100 feet wide and 12 feet deep at mean high tide, and there is no indication of any deterioration.

ESTIMATED COST OF WORK REQUIRED.

Dredging 16,000 cubic yards of sand, measured in place, at 30 cents	$4,800
Constructing 1,000 linear feet of revetment, at $2	2,000
	6,800

SOUTH CHANNEL.

Bar at Rushmore's.—Just below the foot of Puddledock Cut the river attains a width of 400 feet, giving a considerable increase of sectional area and a consequent reduced velocity, causing the formation of a shoal or bar at this point. There are also two lesser shoals, 1,800 feet and 3,000 feet below the foot of Puddledock Cut. It is proposed to remove these shoals by dredging, and it is believed that a permanent channel will be maintained through the bar at Rushmore's by the training-wall recently constructed between Old Channel and Puddledock Cut from the lower end of island, extending about 600 feet down stream, and the permanent closing of Old Channel at the closure dike, which causes a largely increased volume of water to flow through this reach. The two lesser bars should be removed by dredging, which will suffice for a long time to come.

Dredging at Rushmore's and below:	
11,700 cubic yards sand, measured in place, at 30 cents	$3,510

Bar at Gatling's.—It is understood that dredging has been done in this locality several times, but it seems to have filled up completely, as at present there is nothing in the appearance of the bottom to show where the work was done. A recent examination of the cut, 20 feet wide and 12 feet deep, at mean high tide, made through this bar in October and November, 1886, shows that it is filling up rapidly. It is proposed to remove this bar by dredging and to maintain the channel so obtained by reducing the cross-sections to their proper areas by means of jetties and a training-wall. The latter will also prevent the water, at or near high tide, from flowing over the low marsh into Old Channel, and *vice versa*. The cost of the foregoing is estimated as follows:

Dredging 13,300 cubic yards sand, measured in place, at 30 cents	$3,990
Constructing 8 jetties and 1 training-wall, 2,180 linear feet, at $2.50	5,450
	9,440

At the confluence of South and Old Channels there is a slight shoal, having a tortuous 12-foot channel, from 20 feet to 80 feet wide, through it. No work has ever been done here, and the removal of 1,100 cubic yards of sand, measured in place, will secure a channel 100 feet wide and 12 feet deep at mean high tide, which will probably maintain itself without the use of jetties. Should there be a tendency to shoal after dredging, it would be more economical to dredge occasionally than to construct a system of jetties, the cost of construction and maintenance of which would be totally disproportionate to the benefits secured. The cost of dredging 1,100 cubic yards, measured in place, at 30 cents, is $330.

Bar at Sunken Island.—This bar is due to the excessive width of river and the division of the currents, a part of the water flowing around the island. It is proposed to dredge a channel through this bar and secure its permanence by the construction of a training-wall on the western side of the channel, and by the closing of the waterway behind Sunken Island by means of a dike. The latter is now in course of construction. The cost of this work is estimated as follows:

Dredging 6,000 cubic yards sand, measured in place, at 30 cents	$1,800
Constructing 1,300 linear feet of training-wall, at $2.50	3,250
	5,050

At Point of Rocks the 12-foot channel is contracted to a minimum width of 40 feet, which is mainly due to a division of the water, a considerable volume passing up and down behind Sunken Island. This will be obviated by the closing of the channel behind the island at its upper end, which work is now in progress. It is proposed to increase the width of the 12-foot high-tide channel to 120 feet by dredging, which will require the removal of 1,800 cubic yards of sand, measured in place, at 30 cents, $540.

Nothing further should be done here until the full effect of closing the channel behind Sunken Island has been ascertained. It is probable that jetties can be avoided here, which would not only be a saving of funds, but would be advantageous to the entire channel above.

RECAPITULATION.

Dredging 54,250 cubic yards sand, measured in place, at 30 cents	$16,275
Constructing 3,930 linear feet of training-walls and jetties, at $2.50	9,825
Constructing 1,000 linear feet of revetment, at $2	2,000
Repairing old jetties	1,300
	29,400
For engineering and contingencies, 15 per cent	4,410
Total	33,810

Very respectfully, your obedient servant,

H. J. GIELOW,
Assistant Engineer.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

TABLE A.—*Tonnage of the port of Petersburg from July* 1, 1886, *to July* 1, 1887.

Class.	Number of vessels.	Tonnage of vessels.
Schooners	166	18,516.68
Sloops	67	791.01
Steamers	275	40,746.84
Steam-tugs	328	3,114.71
Total	836	63,169.24

TABLE B.—*River commerce of the port of Petersburg—value of articles of freight.*

INWARD FREIGHT.

Articles.	Value.	Articles.	Value.
Coal	$54,095	Peanuts	$42,172
Corn	6,301	Potatoes	2,100
Wheat	8,319	Sumac	4,624
Oats	1,442	Sirup	2,700
Hay, straw, etc	353	Oil	2,300
Ice	26,584	Oysters	3,360
Guano	102,094	Oyster shells	380
Lime (builders)	2,000	Logs	894
Lime (shell)	864	Miscellaneous	2,000
Cement	613		
Cotton	41,230	Total	304,425

OUTWARD FREIGHT.

Articles.	Value.	Articles.	Value.
Barrels	$755	Pine lumber	$30,708
Cotton seed	778	Pine wood	28,421
Guano	9,596	Poplar wood	1,382
Plaster	1,799	Miscellaneous	25,000
Railroad ties	6,484		
		Total	104,923

SUMMARY.

Inward commerce	$304,425
Outward commerce	104,923
Total	409,348

L 5.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

There were no operations during the fiscal year ending June 30, 1887. It was not deemed expedient to resume them, the funds available being insufficient.

The interest of this work in the combined steam hoister and pile-driver, owned jointly by it and the Pamplico and Tar rivers work (transferred during the year to another district), was obtained by the latter on November 23, 1886, under authority of the Chief of Engineers, by the payment to the former of $2,169.69, which was the total amount expended by it thereon.

On May 18, 1887, an incidental cursory examination of the work was made under my personal direction, which showed that the channel was in a fairly navigable condition.

The $40 spent during the fiscal year ending June 30, 1887, was for care of property.

The funds available will be applied to contingencies. The sum of $10,000 can be profitably expended in the fiscal year ending June 30, 1889. It is proposed to apply this to dredging, as set forth in the Annual Report of the Chief of Engineers, 1885, and also to the removal of logs, etc., that have made their appearance since the river was last cleared of them. The most of this is due to the careless handling of log-rafts, for which there should be some legal remedy.

The commercial statistics received from the Albemarle and Chesapeake Canal Company are appended hereto. They also relate to Currituck Sound, Coanjok Bay, and North River Bar, which are on the same inland water-route. Attention is especially invited to the interesting letter of Franklin Weld, esq., president of said company, which bears high testimony to the good results effected by the money appropriated by Congress for the improvement of this very important route.

This river is in the collection district of Norfolk, Va.

Money statement.

July 1, 1886, amount available	$1,500.00
Amount received from sale of combined steam hoister and pile-driver	2,169.69
	3,669.69
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	40.00
July 1, 1887, amount available	3,629.69
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

Trade through the Albemarle and Chesapeake Canal for fiscal year ending June 30, 1887 passing through Elizabeth and North Landing rivers.

GOING NORTH.

Articles.	Quantity.	Articles.	Quantity.
Cotton ... bales	62,404	Wood ... cords	507
Fish ... barrels	7,849	Juniper logs ... do	2,977
Naval stores ... do	4,748	Railroad ties ... number	36,392
Turpentine ... do	34	Potatoes ... bushels	72,456
Eggs ... crates	2,263	Wheat ... do	1,195
Rags ... pounds	4,790	Beans and peas ... do	6,378
Iron ... do	26,900	Lumber ... feet	88,690,030
Rice ... bushels	24,507	Shingles ... number	28,539,984
Peanuts ... do	21,512	Laths ... do	2,110,850
Corn ... do	110,438	Staves ... do	600,680

GOING SOUTH.

Beef ... barrels	9,623	Crockery ... crates	107
Beer ... do	573	Cement ... casks	2,682
Flour ... do	47,362	Oyster shells ... bushels	18,650
Fish ... do	495	Iron ... pounds	1,842,178
Molasses ... do	1,324	Guano ... tons	5,855
Spirits ... do	699	Hay ... bales	16,220
Sugar ... do	2,674	Salt ... sacks	17,742
Coffee ... sacks	974	Plaster ... bushels	75,850
Shoes ... cases	1,455	Oil ... barrels	3,970
Soap ... boxes	1,630	Coal ... tons	2,818
Tobacco ... do	1,574	Ice ... do	3,171
Nails ... kegs	2,074		

Vessels navigating the Albemarle and Chesapeake Canal during the fiscal year ending June 30, 1887.

Direction.	Steamers.	Schooners.	Sloops.	Barges.	Lighters.	Boats.	Rafts.
Going north	1,676	597	97	289	25	3	297
Going south	1,693	619	84	279	24	6	....
Total	3,369	1,216	181	568	49	9	297

L 6.

IMPROVEMENT OF CURRITUCK SOUND, COANJOK BAY, AND NORTH RIVER BAR, NORTH CAROLINA.

The act of August 5, 1886, appropriated $10,000 for this work. A project for the expenditure thereof was duly submitted to and approved by the Chief of Engineers.

Accordingly, on September 22, 1887, proposals were invited for dredging a channel across North River Bar, as described in the Annual Report for 1885, and on October 27, 1887, a contract was entered into with Messrs. James Caler & Son, of Norfolk, Va., to do the work at 13.9 cents per cubic yard, measured in scows. Work under the contract was to have been commenced on or before February 1, 1887, and completed on or before June 30, 1887. It was not, however, commenced until March 2, 1887, owing to the unreasonable and unnecessary delay of the contractors. Their plant was out of repair and not adapted to the work. They worked until March 5, 1887, inclusive, and did no work thereafter. The contract expired unfinished, and Messrs. James Caler & Son are therefore failing contractors.

The number of cubic yards removed by them is 1,037, for which no payment has been made, and the total amount of the contract 65,000, more or less.

On May 5, 1887, the officer in charge recommended that the contract be annulled and the work readvertised, giving reasons therefor. This was not approved by the Chief of Engineers. On June 2, 1887, the officer in charge renewed his recommendation, giving an additional reason therefor. In his reply thereto of June 8, 1887, the Chief of Engineers stated that the contract would be permitted to expire, and authorized the work to be advertised anew, which was done, the proposals to be opened on July 11, 1887. The funds available will be expended accordingly.

It is understood that the Light-House Department will mark this channel, when completed, in the manner proposed in my Annual Report of 1885.

The steam-tender Lucerne was built for use on this and other works. For the details relative thereto see report for this fiscal year on harbor at Norfolk, Va., and its approaches.

On May 18, 1887, a personal examination was made of this work, and it was found that the channel through the sound and bay was in fair condition, the depth being from 7.5 to 8 feet at ordinary winter water. There was 7 feet of water on the bar. The shell dike stood well, with the exception of two breaches that had been unlawfully made for the passage of skiffs.

The sum of $55,122.85 can be profitably expended in the fiscal year ending June 30, 1889. It is proposed to complete the project with this, as set forth in the Annual Report of the Chief of Engineers, 1885. However, work of this character is not susceptible of entire and permanent completion, as more or less dredging must always be done to maintain it. It is estimated that an annual expenditure of $5,000 would be ample for this.

The commercial statistics are the same as those to be found in report on North Landing River, Virginia and North Carolina, for this fiscal year, these works being on the same highly important inland water-route.

Currituck Sound, Coanjok Bay, and North River Bar are in the collection district of Norfolk, Va.

Money statement.

July 1, 1886, amount available		$1,500.00
Amount appropriated by act approved August 5, 1886		10,000.00
		11,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,695.52	
July 1, 1887, outstanding liabilities	33.68	
		1,729.20
July 1, 1887, amount available		9,770.80
Amount (estimated) required for completion of existing project		55,122.85
Amount that can be profitably expended in fiscal year ending June 30, 1889		55,122.85

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for dredging across North River Bar, North Carolina, opened by Capt. F. A. Hinman, Corps of Engineers, at Norfolk, Va., October 22, 1886.

No.	Names and addresses of bidders.	Date of commencement and completion of work.	Number and kind of machines to be used.	Capacity (cubic yards per day).	Price per cubic yard.
					Cents.
1	George E. Ward, Washington, D. C.	Commence on or before December 10, 1886, and complete on or before June 30, 1887.	One or more dipper dredges.	300 each	14.75
2	James Caler & Son, Norfolk, Va.	Commence work on or before February 1, 1887, and complete on or before June 30, 1887.	One or two dipper dredges.	400 and probably 600 or 700.	13.9
3	Thomas P. Morgan, Washington, D. C.	Commence December 1, 1886, and complete by June 30, 1887.	One dipper dredge	400 in fair working weather.	*23

*If any stumps are encountered, $6 per hour for all time consumed in removing same.

Contract with James Caler & Son.

L 7.

IMPROVEMENT OF BLACKWATER RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1887, there being no funds available.

The sum of $2,500 can be profitably expended in the fiscal year ending June 30, 1889. It is proposed to apply this as follows:

Redredging two bars that have shoaled slightly; cutting off projecting points that have only been partially cut off, and removing any logs, snags, etc., that may be found.

The accompanying commercial statistics, received from J. H. Bogart, esq., superintendent of the Albemarle Steam Navigation Company, show that a large business is done on this river. Its business is affected somewhat by two other competing routes; *i. e.*, the Albemarle and Chesapeake Canal and the Norfolk Southern Railroad. However, there appears to be enough for all in this important section of the country.

The small amount required to complete this improvement would be of great benefit to the community near it and of considerable advantage to commerce.

This river is in the collection district of Norfolk, Va.

Money statement.

Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$2,500.00

COMMERCIAL STATISTICS.

Business delivered to and from points on Blackwater and Meherrin rivers by Albemarle Steam Navigation Company from July 1, 1886, *to July* 1, 1887.

South:		
Merchandise	pounds	12,214,787
Guano	do	2,946,863
North:		
Merchandise	do	3,474,289
Cotton	bales	7,981
Peanuts	bags	12,257
Rice	pounds	172,718
Truck	packages	5,054
Fresh fish:		
Boxes		1,554
Half boxes		235
Salt fish:		
Barrels		3,688
Half barrels		2,448

J. H. BOGART,
Superintendent Albemarle Steam Navigation Company.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

L 8.

IMPROVEMENT OF NOTTOWAY RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1887. It was deemed inexpedient to resume them, the funds available being insufficient.

No reliable commercial statistics are available. There is but little traffic over the river.

The proposed improvement should not be completed, as commerce, both present and prospective, does not demand it; therefore no further appropriation is asked for this work.

This river is in the collection district of Norfolk, Va.

Money statement.

July 1, 1886, amount available	$246.16
July 1, 1887, amount available	246.16

L 9.

IMPROVEMENT OF MEHERRIN RIVER, NORTH CAROLINA.

There were no operations during the fiscal year ending June 30, 1887. It was deemed inexpedient to resume them, the funds available being insufficient to do necessary dredging.

The improvement of this river has consisted solely in removing logs, snags, and such like obstructions. No permanent benefit has been derived therefrom, as other similar obstructions are permitted to sink therein and endanger navigation. If this evil could be checked by proper legislation a great improvement could be made and commerce benefited considerably

The sum of $7,500 can be profitably expended in the fiscal year ending June 30, 1889. It is proposed to apply this to dredging and the removal of obstructions like those above that will continue to form.

A portion of the commercial statistics will be found in report for this fiscal year on the Blackwater River, Virginia. There are more, as other lines of boats ply here, but they could not be obtained.

This river is in the collection district of Norfolk, Va.

Money statement.

July 1, 1886, amount available	$415.47
July 1, 1887, amount available	415.47
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	7,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

L 10.

IMPROVEMENT OF EDENTON BAY, NORTH CAROLINA.

There were no operations during the year, none being required. The funds available will be held for contingencies. The balance of the estimate required for the completion of the adopted project is $6,000, but no further appropriation is asked for at present, as Edenton has a harbor amply sufficient for all the present wants of navigation and commerce, which, so far as can be forecast, will suffice for some time to come. It is probable that dredging will be required at long intervals, as the bay has a tendency to silt slowly.

The commercial statistics received from Col. H. C. Hudgins, general freight and passenger agent of the Norfolk Southern Railroad, are appended hereto. There are more of minor importance, but they could not be obtained.

In 1879 the total tonnage was about 150,000 (see page 698, Report of the Chief of Engineers, 1879). That for the past fiscal year is 66,455,575. This enormous increase can be largely attributed to the grand improvement made in this harbor. The work done by the Government has doubtless helped to materially lower the rates of freight of competing lines—for instance, see statement of Franklin Weld, esq., president Albemarle and Chesapeake Canal (a competing line), under report for this fiscal year for North Landing River, Virginia and North Carolina.

Edenton is in the collection district of Albemarle, N. C.,

Money statement.

July 1, 1886, amount available	$447.41
Amount appropriated by act approved August 5, 1886	2,000.00
July 1, 1887, amount available	2,447.41
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Commercial statistics for Edenton Bay, North Carolina, from June 30, 1886, to June 30 1887.

Articles.	Quantity.	Articles.	Quantity.
Lumber ....feet..	1,556,512	Fish, salt........packages..	4,313
Shingles	932,460	Cattle	37
Staves	32,734	Poultry ....packages..	180
Mill logs........feet..	2,122,251	Eggs ....do....	1,229
Railroad ties	57,067	Melons	9,003
Truck........packages..	14,205	Barrel heads	48,600
Rice ....bushels..	2,604	Miscellaneous freight....packages..	8,346
Cotton ....bales..	11,375	Cooper logs ....cords.	1,560
Peanuts ....bushels..	23,316	Juniper logs........do....	470
Fish, fresh ....packages..	7,274		

	Tonnage.	Passengers.
	Pounds.	
North bound	47,474,824	9,312
South bound	18,980,751	7,494
Total	66,455,575	16,806

L II.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

By the hire of labor, the use of a hired diving outfit, a Government plant, and the purchase of materials in open market, the wreck of the steamer *Concord*, referred to in my last annual report, was removed under my personal supervision, in six working days, between May 18 and 29, 1887.

The *Concord* was a wooden vessel, 118 by 22 by 8 feet, and was loaded with cotton on February 20, 1886, when she burnt and sunk in Pamlico River, just below Washington, N. C.

The wreck thereof was duly advertised under the law, but was afterward libeled in the United States District Court and sold at a United States marshal's sale to certain parties in Washington, N. C., who promised to remove all of it. However, after removing the valuable portions thereof they abandoned the balance, which caused delay in getting it out.

The wreck lay on a hard bottom in 8 feet of water, with about 4 feet of water and considerable mud over it, forming a very dangerous obstruction to navigation. By means of a water-jet, holes were made under the bottom for the reception of explosives. Sixty pounds of dynamite (60 per cent. nitro-glycerine) and 250 pounds of triple F powder were properly divided and fired by electricity under and about it. The latter was sealed in jugs. Seventeen shots in all were fired separately. A steam hoister raised the pieces, which were either placed thereon or slung thereto, and then towed to an out-of-the-way place and dumped. Afterwards an inch and a half round iron rod 35 feet long was suspended 8 feet under the bow of the hoister and the whole area formerly occupied by the wreck carefully swept over with it to remove all fragments. It was thus ascertained that the wreck had ceased to be an obstruction to navigation.

Circumstances were necessarily such that the wreck was removed fifteen months after it had sunk and a year after my estimate of $500 was made for its removal. In this time it had silted and changed so that it was more difficult and costly to remove it; consequently the estimate was exceeded, the cost of removing it being $686.72.

L 12.

PRELIMINARY EXAMINATION OF ALLIGATOR RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., November 24, 1886.

GENERAL: I have the honor to render the following report on my personal preliminary examination of Alligator River, North Carolina, made between the 16th and 20th instant, pursuant to the provisions of section 6 of the river and harbor act of August 5 last, and your instructions of the 28th ultimo.

Capt. James Mercur, Corps of Engineers, now professor of engineering at West Point, examined this river four years ago. His full report thereon is inserted herein, immediately below:

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., January 27, 1883.

GENERAL: I have the honor to submit the following report of a preliminary examination of Alligator River, North Carolina, made between November 3 and 9, 1882, in accordance with directions contained in your letters of August 11, and September 27, 1882.

Through the courtesy of Mr. Marshall Parks, president of the Albemarle and Chesapeake Canal Company, who was about to visit Fairfield, I was invited to accompany him upon the canal company's steamboat, which gave me an opportunity for a much better examination than would have been otherwise practicable.

Alligator River rises in the swamps of Hyde County, N. C., and empties into Albemarle Sound near its eastern extremity. Its total length is probably 50 miles. It is navigable by vessels drawing not more than 8 feet for 20 miles from its mouth, and for those drawing not more than 6 feet up to the mouth of the Fairfield Canal, about 13 miles further.

The land throughout its entire length is low and swampy, there being no towns and only four or five landings upon the river.

From the head of navigation the Fairfield Canal Company have a canal about 5 miles long, 30 feet wide, and 5 feet deep, without locks, running to Fairfield, the only town whose commerce is carried over the river.

Fairfield is situated on the banks of Mattamuskeet Lake, and is a town of 225 voters, or probably 1,200 inhabitants. The farming lands around the lake are very good and produce large crops of corn, rice, sweet and Irish potatoes, and other vegetables.

About 100,000 to 125,000 bushels of corn and a small quantity of rice are exported annually, and general merchandise is imported to supply the town and surrounding country, there being enough business carried on to support twelve country stores. One steamboat runs regularly from Fairfield to Elizabeth City, N. C., making two round trips a week, and touching at the other landings on the river, connecting at Elizabeth City with the Elizabeth City and Norfolk Railroad.

The Fairfield Canal Company is an incorporated company, and collects tolls upon boats and freights passing over the canal.

The lower 20 miles of Alligator River is straight and broad, with good depth of water, but has a wreck and one or two bad snags near the channel. The next 8 miles, proceeding upwards, *i. e.*, between Newport News and Cherry Ridge, is crooked, but of good width and depth, but also contains a few snags near the channel. From Cherry Ridge to the mouth of the Fairfield Canal, about 10 miles, the river becomes very narrow, and its crooks and bends are hardly to be described. Its depth, however, in the narrow and crooked part is great, seldom less than 18 feet close to the apparent banks.

The actual banks of the narrow part of the river are not determinable by any ordinary means, as the visible margin of the river is made up of a dense growth of canes and grass with some small trees, which, while in some parts they may send their roots down to solid ground, in others are afloat. This is shown by points being cut off by the steamers and floating down the river as islands until they lodge in some other place, and the roots make them fast again in a new locality. One of these islands, carrying a small cypress tree about 10 feet high, together with grass and canes, was floating in the river when I passed up, and had floated down stream about one-fourth of a mile before my return, the motion being principally due to wind, as there is a very slight current in the river.

The removal of the snags and wreck in the lower river and straightening the upper river are the only improvements which are considered necessary by those interested in the river.

The removal of the wreck and snags would not be difficult or expensive, but the straightening of the upper river would be probably quite a costly operation. No estimate of the cost of this work could be made without a full survey, which would, owing to the character of the river and banks, cost about $1,500.

The pilots say there are ninety-eight crooks in one direction and ninety-nine in the other; around many of these it is necessary to push a steamboat, 75 to 100 feet long, with poles. One of these bends was cut off several years ago by sawing through the canes, roots, etc., and floating the piece cut out, which was about 40 by 60 feet, into the old channel. This cut remains open, while the old channel is closed by material which has floated in and grown fast.

The navigation of this part of the river is tedious and difficult, owing to these short bends, but is entirely safe, as the river is deep, free from snags and stumps, and the banks are of such a character that a boat can not get ashore.

Should the upper river be straightened it would shorten the time from Fairfield to Elizabeth City or other ports about two hours for the boats which can now run on the river, and would admit larger boats to reach Fairfield. This would be a convenience to the inhabitants of Hyde County, and would invite competition and reduce freights, and would probably encourage somewhat greater variety and increase in production in the country. The amount of this probable increase, however, is not such as in my judgment would cause this river to be considered worthy of improvement and the work a public necessity.

Very respectfully, your obedient servant,

JAS. MERCUR,
Captain of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

Captain Mercur's description of the river is of course very correct. My object in going over it was to note any changes that might have occurred since.

At Fairfield I found among the records of the Fairfield Canal and Turnpike Company a tracing of a Coast Survey map of a reconnaissance of the upper part of the river made in 1876. Mr. S. B. Sadler, collector of said canal, very kindly loaned this to me. I have caused the accompanying map to be traced therefrom, making the curves in black instead of in colors, in case it be published, and noting the miles thereon. I also transmit herewith a Coast Survey map of the balance of the river. These two comprise the whole river, 42 miles in length, below the Fairfield Canal. (I shall call this the canal hereafter in referring to it herein.) Above the mouth of the canal nothing is desired on the river, it being very insignificant, so far as navigation is concerned.

I passed over the river on the mail steamer *Martha E. Dickerman*, which is operated by the Norfolk Southern Railroad Company.

* * * * * * *

She makes two round trips per week to Elizabeth City, N. C., carrying the mails. The only other vessel that runs to Fairfield is the schooner *Lena*, that can carry 2,000 bushels of corn.

Fairfield is a hamlet, not far from Mattamuskeet Lake. It is at the head of the canal, and about 4 miles from the river. Between the canal and Kilkenny, about 10 miles, there are no landings on the river, save one at a ditch 3 miles below, where there is a small house for the reception of corn brought over the ditch in pole-boats. The improvement of this particular portion is about all that is asked for by those interested in the river.

The depth is ample, the banks bold and yielding, in a measure. There is no leaning timber; no snags to speak of, only a few logs; and were the stream straight the width would be sufficient. All that is desired is to make cut offs through material the greater part, if not all, of which may well be termed quasi-rafts of reeds, etc., grown together. It is a question how well a dredge-bank would stand. The river is in much better condition than the canal. The latter and the upper part of the former are mere drains, having side drains leading into them. The rise and fall of the water therein is due mostly to the winds, and, of course, to rain. It is not known that any levels have ever been run, but it is quite probable that cut-offs would draw down the canal, which is now too shallow, and it is understood that owing to quicksand it would be expensive to deepen it. It was noticed that a dredge had been there at work lately. It would not injure navigation in the river, however, to draw down its level a little.

The canal company is said to have paid several small dividends since the war, but the most of its revenue is spent on the canal. Its toll on corn is 2 cents a bushel.

It is a fact that this part of the country has been largely reclaimed and improved during the past few years. Last year Mattamuskeet Lake, 20 miles long, 6 miles wide, and 5 feet deep, was drawn down 3 feet by digging a drainage canal 3½ miles in length to Wysocking Bay, an arm of Pamlico Sound, and now another important canal is approaching completion, as stated by Colonel Carter.

Attention is invited to the accompanying communications of Col. William S. Carter, president Fairfield Canal and Turnpike Company, and M. K. King, esq., general manager Norfolk Southern Railroad Company, dated the 16th and 20th ultimo, respectively. * * * Also to a statement of the Fairfield Canal traffic for the last four fiscal years, furnished by Mr. Sadler.

It is thought that the "present and prospective demands of commerce" are fully met now, so far as the river is concerned. When the owners of the canal, the objective point, shall have made the navigation thereof as good as, or better, than that on the river approach thereto, then it will be time for the Government to improve the latter, provided the trade seeking it shall justify any improvement.

In view of the foregoing, I have to report that Alligator River, North Carolina, is not "worthy of improvement."

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.
(Through Lieut. Col. William P. Craighill,
Corps of Engineers, U. S. A.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., November 26, 1886.

Respectfully forwarded to the Chief of Engineers.

I have no personal knowledge of this stream, but, from the evidence before me, conclude that under existing circumstances the improvement of Alligator River should not be undertaken by the United States at this time.

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

LETTER OF M. K. KING, GENERAL MANAGER NORFOLK SOUTHERN RAILROAD COMPANY.

NORFOLK SOUTHERN RAILROAD COMPANY,
GENERAL MANAGER'S OFFICE,
Norfolk, Va., October 20, 1886.

DEAR SIR: Replying to your request for information about the Alligator River, I inclose a statement of the traffic through the Fairfield Canal for the year ending August 31, last, and of the president of the Canal Company, Col. William S. Carter, descriptive of the locality in the vicinity of the head of the river; also of the traffic in and out of the Alligator River carried by this company's steamer, running between Elizabeth City and Fairfield.

The views expressed by Colonel Carter may be received with entire confidence in the representation he makes about the Alligator River. He is qualified by the residence of a lifetime in Hyde County, and by the observation of travel, to speak intelligently upon the subject about which he writes. I concur with him in believing that the Government would be justified in expending up to $10,000 in the improvement of the Alligator River. It is a mail route of increasing importance and it is the outlet for the principal part of several counties which will produce very largely of natural and cultivated products.

Very truly yours,

M. K. KING,
General Manager.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

LETTER OF COLONEL WILLIAM S. CARTER, PRESIDENT FAIRFIELD CANAL AND TURNPIKE COMPANY.

OFFICE OF THE FAIRFIELD CANAL AND TURNPIKE COMPANY,
Fairfield, N. C., October 16, 1886.

DEAR SIR: Yours of the 12th instant, covering report of Captain Mercur, came to hand by last steamer. I send you a statement showing the trade of this canal the past year; and while this statement is correct, it does not show or really convey a correct idea of the amount of work we usually do. Owing to excessive rains last year, the crops were shortened more than one-half. The present year we shall ship from 100,000 to 125,000 bushels corn, between 15,000 and 20,000 bushels rice, about 12,000 bushels oats, and other things in proportion. This is no guess work, as the crops are matured and a part of them housed. The people having something to trade with, the importation of merchandise will be nearly, if not quite, doubled. The registered vote of Fairfield is 261, showing a population of about 1,500. The depth of water in the Fairfield Canal at mean tide, by actual measurement, is a little over 7 feet, and is safely navigable for vessels drawing 6½ feet. I do not know to what extent Captain Mercur proposed to straighten Alligator River, but in my opinion $3,000, judiciously and economically expended, would make all the improvement that would be required on the upper part, *i. e.*, Cherry Ridge Landing to Fairfield Canal. The State, with its convict force, is about completing a large canal from Alligator Lake, in Tyrrell County to Rutman's Creek, in Hyde County. This canal will cut off the press of water from all this section, which has heretofore destroyed the crops, and will, it is thought, render thousands of acres of land valuable that heretofore has been regarded as worthless.

With the highest respect for Captain Mercur and his superior skill in these matters I think that our people think that the Government can well afford to expend the small amount necessary to the improvement of this river.

Very respectfully, yours,

WM. S. CARTER,
President.

M. K. KING,
General Manager.

Statement of grain, merchandise, passengers, etc., carried over the Fairfield Canal from September 1, 1885, *to September* 1, 1886.

Articles.	Quantity.	Articles.	Quantity.
Bread ... barrels	80	Lumber ... feet	99,208
Beef and pork ... do	88	Bricks	21,400
Flour ... do	456	Juniper posts	537
Molasses ... do	26	Buggies and horses	28
Cider and whisky ... do	27	Cattle	52
Sugar ... do	53	Sheep	52
Oil ... do	41	Potatoes ... barrels	210
Lime and cement ... do	68	Hay ... bales	18
Coffee ... bags	62	Corn ... bushels	44,094
Salt ... do	81	Peas ... do	1,538
Hats and shoes ... boxes	82	Oats ... do	11,180
Soap ... do	74	Rice ... do	2,095
Tobacco ... do	120	Wheat ... do	182
Dry goods ... cubic feet	659	Eggs ... dozen	5,010
Nails ... kegs	57	Chickens	2,243
Soda ... crates	67	Small boxes	1,402
Coal ... tons	46	Passengers	365

Statement—Packages, etc., transported over Norfolk Southern Railroad from Alligator River, from September 1, 1885, *to September* 1, 1886.

Articles.	Quantity.	Articles.	Quantity.
Corn ... bushels	29,705	Poultry ... number	395
Wheat ... do	84	Eggs ... packages	817
Oats ... do	4,002	Fresh fish ... boxes	201
Pease ... do	260	Salt fish ... do	108
Truck ... packages	1,544	Merchandise ... packages	1,058
Cattle ... number	220	Rice ... bushels	8,030
Hogs ... do	60	Cotton ... bales	177
Sheep ... do	111	Shingles ... number	17,800

TONNAGE FOR SAME PERIOD.

North-bound	2,807,729
South-bound	1,072,904

Number passengers carried to and from all points on Alligator River during the year ending December 31, 1885, was 842.

NORFOLK SOUTHERN RAILROAD COMPANY,
Norfolk, Va., October 19, 1886.

L 13.

PRELIMINARY EXAMINATION OF NANSEMOND RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., November 23, 1886.

GENERAL: In accordance with the provisions of section 6 of the river and harbor act of August 5 last, and your letter of the 28th ultimo, I have the honor to report, as under, on the "preliminary examination" of Nansemond River, Virginia, made by me on the 9th instant, from the Old Dominion Steamship Company's steamer *Pamlico*. The commander thereof, Captain Swift, afforded me every facility for making the examination.

This river lies wholly in Nansemond County, Va., and drains a portion of the Dismal Swamp. It flows north from Suffolk and empties into the James River 20 miles below, and opposite Newport News.

Vessels drawing from 9½ to 11 feet, depending on the tide, can reach Suffolk, the only place of importance on the river. There are fourteen landings along it.

Its three principal affluents are: (1) Shingle Creek, half a mile below Suffolk, on the easterly side; (2) Burnett's Mill Creek, 3½ miles below Suffolk, on the same side, and (3) Western Branch, 7 miles from Suffolk on the other side. Large quantities of lumber, shingles and wood are shipped over these. It is understood that Bennett's Creek, another affluent, 15 miles below Suffolk, on the easterly side, would be navigable for a distance of 7 miles for large vessels, were the bar at its mouth removed. Valuable truck farms are said to border it.

This stream was surveyed and a map of same made, from Suffolk down for a distance of about 15 miles, in November, 1871, by William Popp, assistant engineer, under the direction of Major (now lieutenant-colonel) William P. Craighill, Corps of Engineers, and later, in 1874, the whole river below Suffolk was surveyed by the Coast Survey. A "blue print" of the map of the latter is transmitted herewith, on which I have marked distances from point to point, dikes, etc.

The only bridge over the river is the iron pivot draw-bridge, with two openings at Suffolk. The head of navigation is about half a mile above this.

The river is very tortuous from Suffolk to Western Branch, there being about a dozen bends in its course; the distance by river is 7 miles, and in a straight line but 3¾ miles, or about half the former distance. The *Pamlico*, 145 feet long, had no trouble in rounding the bends, but could turn around at only one place at Suffolk, and then with great difficulty, the turning-basin being quite inadequate for the purpose. This part of the river is bordered by extensive marshes on the convex side, and steep bluffs on the concave side from 20 to 50 feet high. The marshes are about at the level of high water. The width of the foregoing is from 140 feet at Suffolk to 400 feet at Western Branch, where it ceases to be a mere drain in appearance, and suddenly expands into a fine river over half a mile in width. However, the width from here down is by no means uniform, as it contracts and expands at various points in its course from 2,100 feet to 10,000 feet. The wide places contain flats along the deep channel that have been planted with oysters. The banks are high, and the adjacent land is dotted with fine truck farms. There are no great freshets on the river. The range of the tide is about 4 feet.

From 1873 to 1878, inclusive, Congress appropriated an aggregate of $37,000 to improve this river. All of this has been expended thereon, under the direction of the Engineer Department, as set forth in the Reports of the Chief of Engineers, 1872 to 1880, inclusive, from which I freely quote herein. Work was commenced in July, 1873, and that done since consisted in removing wrecks, two war blockades of piles, etc., snags, and such like obstructions, dredging in the vicinity of Suffolk and at Western Branch Bar, and building several regulating and retaining dikes at the mouth of Western Branch, aggregating about 3,500 feet in length. No work has been done on this river since April, 1880.

I tasted the water at Western Branch and found it quite salt. It is infested with teredo in warm weather. As the dikes were built of timber or mattresses, the teredo destroyed a large portion of them in a few years, and as they were repaired similarly they are now in a dilapidated state from the same cause, and should be replaced with dikes of durability to restore the channel to its former improved condition. So far as the dikes are concerned, this is now but little better than when in its natural state. It is quite free from obstructions, such as wrecks, snags, etc. At the upper end a number of sunken logs endanger vessels, and the dredged channel has deteriorated some.

The following communications bearing on this subject are transmitted herewith:

Letters of Hon. E. E. Holland, mayor of Suffolk, dated October 28 and November 16, 1886, respectively.
Copy of the resolutions of the council of Suffolk, passed on October 26, 1886.
Letter of John H. Wright, esq., dated October 25, 1886.
Letter of W. M. Whaley, esq., dated November 12, 1886.
Letter of R. H. Thompson, esq., dated November 13, 1886.
Petition signed by forty-eight different parties, not dated.

The "Sketch Book of Suffolk, Va., its People and its Trade," sent by Mayor Holland, is omitted. It contains 144 pages of data, advertisements, etc., usually found in such works, and shows that although Suffolk is a very old place, she is growing fast, and will doubtless continue to improve in many ways. Her "present and prospective demands of commerce" are large, the lumber interests alone being immense.

It is very evident from the foregoing that this river is "worthy of improvement" for purposes of navigation, and I so report. In fact, anything done to it now would be in the nature of "continuing the improvement," or maintaining what has already been done by the Government.

The channel is deemed perfectly satisfactory up to a point 15 miles below Suffolk, being at least 18 feet deep; therefore no resurvey of this portion is recommended. The balance should be surveyed again, for the third time, to ascertain its condition and wants. It is estimated that $600 is the least amount that will enable me to resurvey and report on this portion of the river, including a project, with estimate of the cost of improvement proper to be made.

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.
(Through Lieut. Col. William P. Craighill,
Corps of Engineers, U. S. A.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., November 26, 1886.

Respectfully forwarded to the Chief of Engineers.

The improvement of the Nansemond River was commenced some ten years ago under my supervision. It is well worthy of further improvement, which may be readily and cheaply made, and with great benefit to the increased and increasing commerce on it.

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

LETTERS OF HON. E. E. HOLLAND, MAYOR OF SUFFOLK, VIRGINIA.

1.

OFFICE OF E. E. HOLLAND, ATTORNEY AT LAW,
Suffolk, Va., October 28, 1886.

DEAR SIR: Your favor of a few days ago, relative to examination of Nansemond River with a view to its improvement, has been received. I believe that the contemplated improvement is both needed and desired. The commerce of the port of Suffolk has more than quadrupled within the last five years, and is rapidly increasing. In fact, Suffolk is, I am informed, at present, the third shipping port in the State and the largest lumber-shipping port in the State. I have referred your letter to the council of the town of Suffolk, and they have appointed a committee to collect all the available data relative to the present and prospective commerce of the river, and any other facts going to show the necessity of the contemplated improvement. Their report will be forwarded to you at an early date.

Assuring you of my interest in this matter, and willingness to give you any assistance in my power, I am,

Yours, very truly,

E. E. HOLLAND,
Mayor Town of Suffolk.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

2.

OFFICE OF E. E. HOLLAND, ATTORNEY AT LAW,
Suffolk, Va., November 16, 1886.

DEAR SIR: As the special committee appointed for the purpose have been, from some cause delayed in collecting and reporting the statistics asked for, I feel it incumbent upon me, for fear of the danger of the delay, to give you a statement of such facts relative to the necessity of the further improvement of our river as I have in my possession. As to the population of the town of Suffolk and its business, I refer you to a "Sketch Book of Suffolk" (which I this day mail to you), published by Edward Pollock, esq., which contains more information in regard thereto than I could give in a short letter. This little book, I can safely say, is a very good history of the town and its trade, and a perusal of its pages will convince you that Suffolk is not only thrifty and prosperous, but is rapidly assuming the proportions of a city.

The region tributary to the river embraces a portion of the county known as a part of the rich trucking section of eastern Virginia. This section is thickly populated, and I have no hesitancy in saying, includes, with Suffolk, more than half the population of the county—say, at least, 8,000.

We have four railroads passing through and terminating here, the Norfolk and Western, Seaboard and Roanoke, the Suffolk and Carolina, and the Suffolk Lumber Company. The last two terminate at Suffolk. They are both over 25 miles in length, and their owners are contemplating further extensions. These roads go out in a southerly direction, and tap the rich timber and agricultural district beyond the borders of North Carolina, a section, too, in need of the very facilities these roads furnish. These roads are owned and operated by capitalists largely engaged in the lumber business.

The Suffolk Lumber Company's road is used in connection with the Whaleyville Manufacturing Company. You will find from the report of its superintendent, which I inclose, that they will ship from here, by the river, the present year, 25,000,000 feet of lumber and 10,000 cords of wood, and in addition merchandise of the value of $150,000, which is mostly made up of farming products. This road uses in connection with it a regular barge and vessel line from here to Baltimore and other points.

The Suffolk and Carolina road does a business which even exceeds that done by the Suffolk Lumber Company's. I am informed by the president of the Gay Manufacturing Company, which ships all its lumber by this line, that they ship from Suffolk by river 30,000,000 feet of lumber, 15,000 cords of wood, and over $200,000 in value of general merchandise in addition. This company runs in connection with their business from fifteen to twenty vessels per month, and are contemplating running a regular line of steamers from here to Baltimore.

Including the lumber and wood shipped by these companies from Suffolk, I think I can safely say that the business done on the river will amount annually to over $6,000,000. We have two lines of steamers from Suffolk to Norfolk and a steam-barge line from Suffolk to Baltimore.

The deepest draught to Suffolk on high tide is, I am informed, about 10 or 12 feet. This prevents any vessels, except flat-bottoms, from coming here. The trade of the town, and the business done on the river, demand a deeper draught, certainly not less than 14 feet.

Our people feel that their river has been greatly neglected, and that other streams on which nothing like the same amount of business is done, having received large appropriations, that they have a right to ask that one be made for the Nansemond sufficient to make the improvements which the increasing trade on it absolutely demands.

Hoping you will give this matter your most favorable consideration, and still assuring you of my readiness at any and all times to furnish you with any data in reference thereto in my power,

I am, sir, yours, very truly,

E. E. HOLLAND,
Mayor of Suffolk.

Indorsed by the committee.

C. H. CANSEY.
A. S. ELEY.
JAMES R. BAKER.
JOHN B. PINNER.

Capt. F. A. HINMAN,
Corps of Engineers.

LETTER OF MR. JOHN H. WRIGHT.

[John H. Wright, attorney and counselor at law.]

SUFFOLK, VA., *October* 25, 1886.

DEAR SIR: Your letter of 23d instant, addressed to the mayor of Suffolk, has been by him submitted to me, with a request that I would write out my views upon the propriety of further expenditures by the Government in the improvement of navigation on the Nansemond River. This river is now the route of a very busy commerce, with numbers of vessels loading at the wharves in Suffolk and destined to New York, Philadelphia, Baltimore, and other ports. In the value of its shipments Suffolk is the third port in the State, and it is the largest lumber shipping port in the State. In addition to cord-wood and railroad ties the shipments of sawed lumber amount to millions of feet per month. The Suffolk Lumber Company's railroad and the Suffolk and Carolina Railroad, both extending from the wharf in Suffolk a distance of 25 or 30 miles into North Carolina, and both lengthening their lines, are devoted mostly to the transportation of lumber. One mill of the Suffolk Lumber Company has a capacity of 70,000 feet per day, and is run to its capacity; others of the same company manufacture each 20,000 to 30,000 feet per day. The mills on the Suffolk and Carolina Railroad have a capacity nearly equal to the above, and by far the greater part of this immense manufacture is shipped down the Nansemond River. Thirty to forty thousand cords of wood per annum and large quantities of railroad cross-ties take the same route. For this transportation a considerable fleet of vessels is required, and many of them are of large size.

In addition, the farms on Nansemond River have been greatly improved of late, and their products increased. This has induced the Old Dominion Steamship Company to put on a daily steamer from Suffolk to Norfolk, and there is, besides, a tri-weekly steamer on same route. But navigation is somewhat obstructed by the formation of bars at the mouth of the Western Branch and another near Suffolk. By all means these should be removed; and there are points at which the removal of some abrupt angles would greatly help navigation. These will readily suggest themselves upon an inspection of the river. There is every reason why this stream, so important and essential to the commerce of this section, should have every obstruction to its navigation removed, and I am glad to know provision was made last winter for a preliminary survey, and am convinced when you make the survey you will be so impressed with the necessity of doing the needed work and with the commercial importance of the stream, that you will not hesitate to recommend an appropriation sufficient to accomplish the desired end.

Very respectfully,

JNO. H. WRIGHT.

Capt. F. A. HINMAN,
Engineer Corps.

LETTER OF MR. W. M. WHALEY.

[Whaleyville Manufacturing Company, manufacturers of yellow-pine lumber.]

WHALEYVILLE, VA., *November* 12, 1886.

DEAR SIR: In reply to inquiry relative to the business done by the Suffolk Lumber Company on the Nansemond River, I will say it runs as follows:

Our lumber that is carried by our barge line and vessels will count about 25,000,000 feet for this year. In addition to this we handle about 10,000 cords of pine wood, which is carried to New York by water, going out to sea by the river. The bulk of the merchandise handled on the line of our railroad is about $150,000 yearly by the river. Our railroad has 15 miles in Virginia and 12 miles in North Carolina. Mail and passengers are carried on mixed trains, two trains daily.

Very respectfully,

W. M. WHALEY,
Superintendent.

E. E. HOLLAND,
Suffolk, Va.

LETTER OF MR. R. H. THOMPSON.

OFFICE OF SUPERINTENDENT
SUFFOLK AND CAROLINA RAILROAD COMPANY,
Suffolk, Va., November 13, 1886.

DEAR SIR: In response to your inquiries I have to say that we now have 28 miles of railroad in operation, and the products of four saw-mills on the line of the road are now brought to the Nansemond River here for shipment. A steam-boat, run in connection with our road, and which plies between Norfolk and Suffolk, carries the miscellaneous freight, but our lumber and cord-wood are carried in sailing vessels. The captains of these vessels all complain of difficulty in getting to and from our port on account of bars and insufficient depth of water in the channel. According to the best information I have, the depth of channel is from 8 to 12 feet at high tide, and we ought to have a depth of 12 to 16 feet at high tide.

Business on the river is steadily increasing. For instance, a new saw-mill has just been started on the line of our road which will cut 60,000 feet of lumber per day, all of which will be shipped by water, and which alone will require two or three vessels per week to carry its product to market.

Earnestly desiring the improvement of the channel of the Nansemond River, I remain,

Yours, very truly,

R. H. THOMPSON,
Superintendent.

Mr. E. E. HOLLAND.

RESOLUTIONS OF THE COUNCIL OF SUFFOLK, VIRGINIA.

At a special meeting of the Council of Suffolk, Va., held on October 26, 1886, to consider a letter received by the mayor from Capt. F. A. Hinman, of the Engineer Corps of the United States Army, in regard to the question of making a preliminary examination of the Nansemond River, the following action was had:

Be it resolved,

(1) That recognizing the importance and need of the improvement of the Nansemond River as a necessity to meet the present and constantly-increasing demands of commerce from and to this port, the Council of Suffolk, Va., is pleased to learn of the provision of Congress in its last river and harbor bill for a preliminary examination of the river.

(2) That we hereby give expression to our belief of the necessity of such examination, with the full confidence that when made it will justify the outlay and demonstrate that improvements are both needed and deserved.

(3) That a committee from the council and citizens of the town be appointed to collect all available data concerning the past, present, and prospective commerce of the river, and forward the same to the United States engineers at Norfolk, Va.

(4) That our assistance and co-operation be, and are hereby, extended to Capt. F. A. Hinman and his corps, in any way we can be of service regarding the examination.

(5) That a copy of these resolutions, duly authenticated, be at once forwarded by the clerk to Capt. F. A. Hinman, captain of Engineers, United States Army, at Norfolk, Va.

A true copy from the record. *Teste—*

[Suffolk, Va., seal; incorporated May, 1742.]

WM. W. MURRAY,
Clerk.

PETITION RELATIVE TO NANSEMOND RIVER, VIRGINIA.

DEAR SIR: We, the undersigned, would respectfully call your attention to the obstructions in the western part of Nansemond River, out of which there is a large, constant, and increasing trade of vessels to New York, Philadelphia, Baltimore, and Norfolk, and other points.

There are two or three mud bars and other obstructions which are a very serious impediment and drawback to the navigation of the river. Clearing out these obstructions would prove a public benefit to this section; it is really needed, and in our opinion a few thousand dollars for that purpose could not *be better appropriated anywhere.*

We would therefore respectfully and earnestly ask you, in your examination of the Nansemond River, to give this part of it your kind attention.

Respectfully,

John Harrell, C. C. Thompson, G. W. Bunting & Sons, Jas. W. Hall, J. G. Martain, David Jackson, D. C. Thompson, S. L. Saunders, Lewis Jackson, N. S. Buck, Thomas Pruden, Jacob H. Northfleet, W. L. Daughtrey, A. B. Hargrowes, E. M. Darden, Mathew Gardner, G. W. Whitley, Uriah Browder, Scott Whitley, John F. Uzzen, P. R. Turner, J. F. Eley, David Outland, Junius Spivey, James Creecy, James Arnold, Sydney T. Ellis, member board supervisors; Townsend Phifer, ship-master; Mike Phifer, ship-master; S. W. Capron, J. E. Webster, J. A. Kirk, lumber manufacturer; C. T. Minton, N. B. Peck, T. J. Saunders, jr., W. T. Phillips, S. C. Bartlett, Richard Peel, Aaron Archer, Joseph Saunders, sr., Adolphus Saunders, Joseph Saunders, jr., Willie Wills, A Harrell, John Hirst, F. N. Gray, R. J. Bartlett, Joseph Mathews.

Capt. F. A. Hinman,
Engineers, U. S. A.

SURVEY OF NANSEMOND RIVER, VIRGINIA.

United States Engineer Office,
Norfolk, Va., September 2, 1887.

General: I have the honor to submit the following report on the survey of the Nansemond River, Virginia, made under my direction, to comply with the requirements of the river and harbor act of August 5, 1886, and your instructions of March 16, 1887.

The field work of this survey covered 15.8 miles and was executed by Mr. H. J. Gielow, assistant engineer, April 21 to May 14, 1887, inclusive. Since then he has been engaged, in connection with other duties, in preparing his report and maps, which are transmitted herewith. The maps consist of one general and five detail sheets.

The $400 allotted to this survey was all expended thereon.

A full description of the river, its present and prospective importance, and the general commercial statistics relative thereto, are given in my report to you dated November 23, 1886, on my preliminary examination thereof. This need not be repeated except to state briefly that it is an important water-route, with a large and rapidly increasing commerce, consisting of lumber, oysters, truck, merchandise, etc. The General Government has already expended $37,000 in improving it and would make no mistake in continuing the improvement.

Mr. Gielow has traversed the whole subject in a careful and painstaking manner. He is thoroughly competent to deal with it, and his views thereon meet with my approval.

The "estimates of cost of improvement proper to be made" are for a channel not less than 100 feet wide at bottom and at least 12 feet deep at mean low water, from the head of navigation to the mouth of Western Branch, 7.37 miles, including a turning-basin 200 feet square, 300 feet below Suffolk Bridge, by dredging and the construction of sixty-one short spur-dams and two training-walls, and a channel of like depth, at same stage, from the mouth of Western Branch to the deep water at Town Point, 8.30 miles, having a width at bottom of at least 200 feet at its upper end and gradually increasing to at least 400 feet at its lower end, by dredging and the construction of one training-wall, at a total cost of $152,500, in round numbers. This sum could be judiciously ex-

pended in a single year, and on the score of economy should be ap
priated accordingly.

The plan of improvement does not contemplate any change in the
of the sectional areas of the river, but it does propose such chang
their forms as will best subserve them to the requirements of naviga

It is proposed to creosote the wooden structures—twenty-two
dams and three training-walls—in the lower portion of the river, as
part only is infested with the teredo.

The ruling depth now is 8.3 feet at mean low water. A channel n
50 per cent. deeper—12 feet deep at this stage or 15 feet deep at
high water—seems to be about the limit of economical improvement
commensurate with the requirements of navigation and commerce
would cost $57,000 more to secure an additional foot in depth.

The estimate for the foregoing is as follows:

Dredging 267,734 cubic yards of material measured in place, at 30 cents..	$80,
Constructing 2,640 linear feet of spur-dams at $2	5,
Constructing 1,220 linear feet of spur-dams creosoted, at $4..............	4,
Constructing 7,700 linear feet of training-wall, creosoted, at $6.25........	48,
	138,
Add 10 per cent. for engineering and contingencies	13,
Total	152,

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engine

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. William P. Craighill,
Corps of Engineers, U. S. A.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., September 10, 18

Respectfully forwarded to the Chief of Engineers. The improve
while not expensive, has been successful from an engineering po
view and of decided advantage to commerce. Its continuance is re
mended.

WM. P. CRAIGHILL,
Colonel of Engine

REPORT OF MR. H. J. GIELOW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., August 31,

CAPTAIN: In compliance with your verbal instructions, I have the honor
mit the following report on the survey of the Nansemond River, Virginia, fr
head of navigation to the 18-foot channel at Town Point, 15.82 miles, accom
by one general and five detail maps.

The survey was made in twenty-one working days, from April 21 to May 14,
inclusive, during which time 30.25 miles of transit line were run and 11,419
ings taken.

From the head of navigation to the mouth of Western Branch a transit li
run along the right bank of the river, closely following the water's edge and
point departing more than 150 feet from it. From points in and perpendic
this line a wire, marked at intervals of 20 feet, was stretched across the stream
opposite bank, and a sounding taken at each mark; these cross-sections were
100 feet apart in the shoal parts of the river, and 150 feet apart where the de
water was ample without improvement. The topography was sketched 400 f
land from the transit line, and sufficient points were located by stadia measure
and by "pacing" to secure accuracy. From the mouth of Western Branch to

Point tripods were established on the salient points of both banks, and located by means of triangulation with a transit, starting from a base 1,982 feet long, just above the mouth of Western Branch, and ending on a closing base, 2,727 feet long, near Town Point. These points were connected by a continuous transit line on each bank and the topography taken in the same manner as between Western Branch and the head of navigation. The width of this portion of the river being too great to admit of stretching a wire from bank to bank for cross-sectioning, stakes, with flags of different colors, were set out at intervals, averaging 250 feet, in a straight line, along one side of the channel, and their positions located by triangulation from the primary points on shore; perpendicular to this line and opposite each stake a stake with a similar flag was set out on the other side of the channel, which, with objects on shore, furnished the necessary ranges for straight lines of soundings, practically perpendicular to the axis of the channel, parallel to each other, and an average distance of 250 feet apart. The sounding-boat being rowed along these lines, soundings were taken at intervals of 15 seconds, every fourth sounding being located by a transit observation from shore, the instrument being so placed as to intersect the straight lines of soundings as nearly at right angles as possible. The distances between soundings average 50 feet. Each reach was staked off and sounded in the foregoing manner.

During the progress of the survey, twenty-one days, simultaneous tidal observations were made hourly at Newman's Point, 1.16 miles above Town Point, and at Suffolk Bridge. Mean low water, as determined from these observations, is 9.5 feet below top of coping of first pier from north abutment of Suffolk Bridge. The soundings were reduced to mean low water, the plane of which was assumed to lie in a straight line between the established points at Newman's Point and Suffolk Bridge, and the velocity of the tidal wave was considered practically uniform between these points. The latter supposition seems to be confirmed by a limited number of current observations made at Suffolk Bridge, Western Branch, and Newman's Point.

The Nansemond River proper lies wholly in Nansemond County; its principal tributaries from the east are Shingle Creek and Burnett's Mill Creek, 0.6 and 3.3 miles below Suffolk Bridge, respectively, and Bennett's and Nott's creeks, both below Town Point; the only important tributary from the west is Western Branch, 6.9 miles below Suffolk Bridge, a considerable stream, rising in the Western part of Isle of Wight County, draining 83 square miles, or 53,120 acres, and discharging 42,487,000 cubic feet of water during one ebb; it is said to be navigable for small craft a distance of 12 miles.

The head of navigation is 0.45 mile above Suffolk Bridge, and from this bridge to the buoy marking the entrance over the outer bar is 21.7 miles, measured by river. The ruling depth on this bar is 16 feet at mean low water.

The river at one time was an arm of the sea, the shores of which are marked by steep bluffs, 20 to 40 feet high, composed of loam, clay, with small sea-shells, and marl beds. Washings from the higher grounds and vegetable matter have gradually formed soft marshes between these shores, ranging in elevation from mean high water to 0.5 foot above it, through which the stream takes its serpentine course, in some places running along the base of a bluff and in others flanked by marshes on both sides. Below the mouth of Western Branch the formation of the marshes has not progressed as far as above that point, the made material having an elevation ranging from low water to 1 foot below it, and is generally designated as "mud flats," but there is strong evidence of a gradual encroachment of vegetable growth on these flats.

A straight line drawn from Suffolk Bridge to mid-channel opposite Town Point, passing through the mouth of Western Branch and 1,000 feet east of Sleepy Hole, has a magnetic of N. 31° E.; but the course of the river ranges from S. 77° 25′ W. through north to S. 15° 20′ E., or through an arc of 267° 15′. The difference in distances in air line and by river is as follows:

Localities.	Distances between localities.			Distances from Suffolk Bridge.		
	Air line.	By river.	Difference.	Air line.	By river.	Difference.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Suffolk Bridge						
Western Branch	3.64	6.91	3.27	3.64	6.91	3.27
Sleepy Hole	3.94	4.79	0.85	7.58	11.70	4.12
Town Point	3.31	3.51	0.20	10.89	15.21	4.32

There are no freshets, as the country drained is comparatively level, so that the water due to rain-falls is slow in running off. The total water-shed is small, being 198 square miles, or 126,720 acres; of this the river above Western Branch drains 82.25

square miles; between Western Branch and Town Point, 9.75 square miles; below Town Point, 23 square miles; and Western Branch drains 83 square miles. The average annual rain-fall in this section is 51 inches, and assuming that eight-tenths of this water reaches the river, the volume of discharge of the main stream just above Western Branch, during one ebb, would be 10,780,000 cubic feet, and for Western Branch 10,680,000 cubic feet. Actual gauging gives the discharge at 82,080,000 and 42,487,000 cubic feet, respectively, showing that 87 per cent. of the water flowing in the main stream above Western Branch is due to the tides. The volume of water passing under Suffolk Bridge during one flood is 23,760,000 cubic feet.

The mean rise and fall of tides is 3.78 feet at Suffolk Bridge, and 3.01 feet at Newman's Point. This, however, is considerably modified by the direction of winds, the maximum rise and fall being 4.33 feet at Suffolk Bridge and 3.64 feet at Newman's Point, while the minimum is 2.50 feet at the former and 2.06 feet at the latter. The difference of time between high water at the above-named places is 1 hour and 13 minutes, and the difference for low water is 1 hour and 1 minute, or a mean difference of 1 hour and 7 minutes. There is but a slight difference in the duration of tides, as shown in the following table:

Tides.	Suffolk Bridge.				Newman's Point.			
	Ebb.		Flood.		Ebb.		Flood.	
	H.	*M.*	*H.*	*M.*	*H.*	*M.*	*H.*	*M.*
Maximum duration of	6	28	6	48	6	36	6	40
Minimum duration of	5	52	5	24	5	48	5	20
Mean duration of	6	07	6	00	6	05	6	12

The only structure across the navigable portion of the river is an iron wagon-bridge at Suffolk, having a draw with two openings, each 42.5 feet in the clear. From this bridge to the mouth of Western Branch the river has an average width of 250 feet, the least width being 190 feet, and the greatest 410 feet. The shoalest place is 3.33 miles below Suffolk Bridge, having a depth of 8.3 feet at mean low water. A depth of 32 feet exists in some of the bends. From Western Branch to Town Point the width averages 2,600 feet, ranging from 800 to 5,800 feet, but the channel is comparatively narrow and tortuous, the widths between the 6-foot curves ranging from 400 to 1,600 feet, and between the 12-foot curves from 200 to 450 feet. The 12-foot channel is not continuous, however, having four shoals in it between the points named, the ruling depth being 10 feet at mean low water.

The tidal currents seem to have a nearly uniform velocity, the greatest velocities observed being 1.47 feet per second or 1 mile per hour at Suffolk Bridge, 1.33 feet per second, or 0.89 mile per hour, in mouth of Western Branch, and 1.70 feet per second, or 1.15 miles per hour, at Town Point. The last is probably too great, as the wind was blowing at a velocity of from 20 to 24 miles per hour in the same direction as the tide was running.

The value of commerce on this river has increased from $1,000,000 in 1872 to over $6,000,000 in 1886, and is still increasing. The principal articles of shipment are lumber, cordwood, railroad ties, truck, and oysters.

From 1873 to 1878, inclusive, Congress appropriated $37,000 for the improvement of this river, which was duly expended for that purpose. Work was commenced in 1873, and during that year all overhanging and fallen trees and two war blockades of piles were removed, and 2,156 linear feet of training-wall was built opposite the mouth of Western Branch. In 1874 a channel 75 feet wide and 7 feet deep was dredged through Western Branch Bar. In 1875 the training-wall opposite the mouth of Western Branch was lengthened 251 feet, 382 linear feet of training-wall of piles and planks and about 700 linear feet of brush was built in the up-stream angle between the river and Western Branch, and the channel through the bar at this point enlarged by dredging, to a width of 100 feet and a depth of 10 feet at mean low water; two wrecks were also removed. From November 25, 1875, to January 5, 1876, a channel 60 feet wide and 7.5 feet deep, at mean low water, was dredged through the shoal below Suffolk Bridge; in 1877 this channel was enlarged, by dredging, to a width of 80 feet and a depth of 8 feet at mean low water, and a channel of same dimensions was dredged through the shoal just below Shingle Creek, and the training-wall opposite the mouth of Western Branch was repaired at a cost of $2,835. In March and April, 1880, 1,120 linear feet of new training-wall was built immediately in front of the older portion, which was in bad condition, and minor repairs were made to the newer portions. No work has been done since, there being no funds available.

The dredged channel through the shoal below Suffolk Bridge is, after a lapse of ten years, practically as good as when made. The same is true of the channel through the shoal below Shingle Creek. The 10-foot channel through Western Branch Bar is in fair condition at its upper portion, but the lower portion has deteriorated, having a concave bottom with a depth of 10 feet at the middle and only 9 feet at the sides. This deterioration is due to the almost total destruction of the training-walls at the mouth of Western Branch by the teredo, the sheet-piling of the upper 1,120 feet of which is still standing, but will not last over a year longer; for the next 925 feet no sheet-piling remains; about one-half remains for the next 185 feet, and the last 185 feet is still intact.

An examination of the cross-sections of the river shows that there is practically a uniform increase of sectional area from 0.25 mile below Suffolk Bridge to the mouth of Western Branch, the low-water cross-section being 1,800 square feet at the former and 3,300 square feet at the latter, and the high-water cross-section 2,900 and 4,200 square feet, respectively. This uniformity of cross-sections is due to a nice adjustment of depth to width, the wide portions of the river having less depth than the narrow ones. The tides having established and maintained this sectional area it appears safe to assume it as the proper one to be maintained. The sectional area being decided on, its width and depth should be proportioned so as to admit of its greatest capacity being utilized by craft of fair proportions. As the river is very crooked the width must be much greater to admit of turning the sharp bends than would be necessary for a straight channel. A careful consideration of all data bearing on this subject leads to the conclusion that a depth of 12 feet at mean low water complies with the above condition. The depth above Western Branch being fixed at 12 feet it should be the same below.

It is therefore proposed to secure a channel not less than 100 feet wide at bottom and at least 12 feet deep at mean low water, from the head of navigation to the mouth of Western Branch, including a turning-basin 200 feet square, 300 feet below Suffolk Bridge, by dredging and the construction of spur-dams and two training-walls; and a channel of same depth, from the mouth of Western Branch to the deep water at Town Point, having a width at bottom of at least 200 feet at its upper end and gradually increasing to at least 400 feet at its lower end by dredging and the construction of a training-wall.

As 87 per cent. of the water flowing in the river above Western Branch is due to the tides, spur-dams can not be relied on for the improvement of this portion of the river, as their construction in the wider portions of the river would reduce the sectional area too much and prevent the free flow of the tides. A slight improvement would, no doubt, be effected in their immediate vicinity, but a corresponding deterioration, would, with equal certainty, take place in other parts of the channel on account of the reduced volume and velocity of the water. It is therefore proposed to dredge this part of the channel and then secure its permanence by the construction of spur-dams.

Below the mouth of Western Branch there are four shoals that require dredging. The width at the bottom of the dredged channel should be 200 feet for the two upper shoals (Nos. 15 and 16) and 300 feet for the two lower (Nos. 17 and 18), so as to conform to the existing 12-foot low-water channel above and below each. A training-wall will be required to maintain the channel through Shoal No. 15, but the channels through Shoals Nos. 16, 17, and 18 will probably be self-sustaining. At any rate, if shoaling should take place, its progress will be so slow that occasional dredging would be the cheapest remedy.

It is proposed to build the spur-dams by driving piles at intervals of 6 feet, center to center, with an 8 by 10 inch waling piece at top, boxed 3 inches into face of piles and fastened with 1-inch screw-bolts, another waling piece 5 by 8 inches to be fastened to piles at low-water mark with ¾-inch drift bolts; sheet-piling 3 inches thick to be driven on up-stream side and spiked to waling pieces with 7-inch wrought-iron spikes. A large guard-pile is to be driven at the end of each spur-dam and left to project 8 feet above high water. All spur-dams and training-walls should be built to the height of the adjacent marshes, and the timber in all structures below Shoal No. 11 should be creosoted. The training-walls should be constructed the same as the spur-dams, sheet-piling being on side away from channel and secured to large brace-piles driven 12 feet from sheet-piles and 12 feet apart, between centers.

The estimated cost of this improvement is as follows:

Shoal No. 1, above Suffolk Bridge (1,000 feet long):	
Dredging 13,726 cubic yards of material, at 30 cents	$4,117.80
Shoal No. 2, below Suffolk Bridge (2,600 feet long):	
Dredging 33,615 cubic yards of material, at 30 cents (channel)	10,084.50
Dredging 5,148 cubic yards of material, at 30 cents (turning-basin)	1,544.40
	11,628.90

Shoal No. 3, below Shingle Creek (1,100 feet long):	
Dredging 11,730 cubic yards of material, at 30 cents	$3,519.00
Constructing five spur-dams, 510 linear feet, at $2	1,020.00
	4,539.00
Shoal No. 4 (700 feet long):	
Dredging 1,325 cubic yards of material, at 30 cents	397.50
Shoal No. 5 (1,000 feet long):	
Dredging 4,030 cubic yards of material, at 30 cents	1,209.00
Shoal No. 6 (1,100 feet long):	
Dredging 9,710 cubic yards of material, at 30 cents	2,913.00
Constructing eight spur-dams, 610 linear feet, at $2	1,220.00
	4,133.00
Shoal No. 7 (2,100 feet long):	
Dredging 22,748 cubic yards of material, at 30 cents	6,824.40
Constructing nine spur-dams, 590 linear feet, at $2	1,180.00
	8,004.40
Shoal No. 8 (1,700 feet long):	
Dredging 15,594 cubic yards of material, at 30 cents	4,678.20
Constructing thirteen spur-dams, 720 linear feet, at $2	1,440.00
	6,118.20
Shoal No. 9 (400 feet long):	
Dredging 850 cubic yards of material, at 30 cents	255.00
Shoal No. 10 (1,300 feet long):	
Dredging 8,378 cubic yards of material, at 30 cents	2,513.40
Constructing 4 spur-dams=210 linear feet, at $2	420.00
	2,933.40
Shoal No. 11 (800 feet long):	
Dredging 6,204 cubic yards of material, at 30 cents	1,861.20
Shoal No. 12 (1,300 feet long):	
Dredging 11,585 cubic yards of material, at 30 cents	3,475.50
Constructing 7 spur-dams, creosoted, 380 linear feet, at $4	1,520.00
	4,995.50
Shoal No. 13 (2,200 feet long):	
Dredging 12,304 cubic yards of material, at 30 cents	3,691.20
Constructing 15 spur-dams, creosoted=840 linear feet, at $4	3,360.00
	7,051.20
Shoal No. 14, Western Branch Bar (2,300 feet long):	
Dredging 14,737 cubic yards of material, at 30 cents	4,421.10
Constructing 2 training-walls, creosoted=4,270 linear feet, at $6.25	26,687.50
	31,108.60
Shoal No. 15 (3,700 feet long):	
Dredging 40,560 cubic yards of material, at 30 cents	12,168.00
Constructing 1 training-wall, creosoted=3,430 linear feet, at $6.25	21,437.50
	33,605.50
Shoal No. 16 (2,700 feet long):	
Dredging 32,975 cubic yards of material, at 30 cents	9,892.50
Shoal No. 17 (1,600 feet long):	
Dredging 11,185 cubic yards of material, at 30 cents	3,355.50
Shoal No. 18 (2,700 feet long):	
Dredging 11,339 cubic yards of material, at 30 cents	3,401.70

The material to be removed by dredging is a soft black mud, mixed with about 10 per cent. of fine sand in the vicinity of Western Branch, and increasing to about 20 per cent. near Suffolk. Considerable clay was noticed in Shoals Nos. 8, 11, 12, and 16. The estimated quantities and price are for material measured in place.

RECAPITULATION.

Dredging 267,734 cubic yards of material, at 30 cents	$80,322.90
Constructing 2,640 linear feet of spur-dams, at $2	5,280.00
Constructing 1,220 linear feet of spur-dams, creosoted, at $4	4,880.00
Constructing 7,700 linear feet of training-wall, creosoted, at $6.25	48,125.00
Add 10 per cent. for engineering and contingencies	13,860.79
Total	152,468.69

To increase the depth of the low-water channel from 12 to 13 feet, one foot more, would require the removal of 190,000 cubic yards of material measured in place, which, at 30 cents per cubic yard, would be $57,000.

The proposed structures and channel are shown in red on the accompanying maps.

Very respectfully, your obedient servant,

H. J. GIELOW,
Assistant Engineer.

Capt. F. A. HINMAN,
Corps of Engineers.

APPENDIX M

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

REPORT OF CAPTAIN WILLIAM H. BIXBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Pamlico and Tar Rivers, North Carolina.
2. Contentnia Creek, North Carolina.
3. Trent River, North Carolina.
4. Neuse River, North Carolina.
5. Inland waterway between New Berne and Beaufort, North Carolina.
6. Harbor at Beaufort, North Carolina.
7. Inland waterway between Beaufort Harbor and New River, North Carolina, through Bogue Sound.
8. New River, North Carolina.
9. Black River, North Carolina.
10. Cape Fear River, North Carolina.
11. Yadkin River, North Carolina.
12. Waccemaw River, South Carolina.
13. Great Pee Dee River, South Carolina.
14. Harbor at Georgetown, South Carolina.
15. Winyaw Bay, South Carolina.
16. Santee River, South Carolina.
17. Wateree River, South Carolina.
18. Congaree River, South Carolina.
19. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

20. Lockwood's Folly River, North Carolina.
21. Lumber River, North Carolina.
22. Mingo Creek, South Carolina.
23. Clark's Creek, South Carolina.
24. Little Pee Dee River, South Carolina.
25. Alligator River and other waters connecting Santee River and Bull's Bay, South Carolina.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., August 3, 1887.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1887, upon the works of river and harbor improvements then in my charge.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 1.

IMPROVEMENT OF PAMLICO AND TAR RIVERS, NORTH CAROLINA.

The Pamlico and Tar rivers are different portions of a single stream. The upper portion, called the Tar, has a total length of about 180 miles and a drainage area of 3,200 square miles, and changes its name to the Pamlico at the town of Washington, N. C. The Pamlico has a further length of about 37 miles and a further drainage area of 1,700 square miles, and finally widens out into Pamlico Sound. The combined rivers, therefore, have a total length of about 217 miles and a total drainage area of about 4,900 square miles. Prior to governmental improvement in 1876 the Pamlico River had an available depth of only 3 feet at low water in its upper portion near Washington; thence Tar River had during eight months of the year an available depth of from 2 to 3 feet for 49 miles, up to Tarborough, its practicable limit of navigation; but its channel was almost completely obstructed by two war blockades, and by floating and sunken stumps and logs and by overhanging trees. Its steamboat commerce was about $500,000.

The original project of 1876 (for the Pamlico) and of 1879 (for the Tar), as since slightly modified and continued to date, proposed for $58,000 to secure a clear and safe channel 9 feet deep at low water up to Washington; thence a channel 60 feet wide and 3 feet deep at low water 23 miles further to Greenville; and thence a channel 60 feet wide and 20 inches deep 26 miles further to Tarborough. These estimates were based upon an insufficient knowledge of the extent of the sunken natural obstructions in the Tar River. A personal inspection of the river (as soon as possible after assuming charge in 1886) showed me this fact, while, moreover, showing the agricultural richness of the river basin, its need of water transportation, and the worthiness of the improvement. Moreover, inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all these reasons the estimates for the final cost of the work are now raised to $75,000. The total amount appropriated for this project up to June 30, 1887, is $58,000, the appropriation for the two rivers being consolidated in 1880.

Fifty-six thousand one hundred and twelve dollars and sixty-one cents has been spent in all upon this improvement up to June 30, 1887, in securing a good channel at least 9 feet deep at low water and at least 108 feet wide from Pamlico Sound 37 miles up to Washington; thence a fair channel, 60 feet wide and 3 feet deep all the year, 23 miles, to Greenville; and thence a similar channel for eight months of the year, 26 miles, to Tarborough. In consequence of this, ten steamers run regularly to Washington, thence two steamers run tri-weekly all the year to Greenville, and eight months of the year to Tarborough. The present commerce is rapidly increasing, and is at present about $2,300,000 of goods transported per year, showing that each dollar spent upon this improvement has been accompanied by a development of $32 in annual commerce. Besides this, the rates of freight are estimated as having been lowered from 12 to 25 per cent. since the commencement of the improvement.

The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The navigation of this river is not obstructed by bridges without draws.

The special work of the year is as follows: Expenditures, $5,330.97; value of United States plant, $2,317. Charge of work transferred from Capt. F. A. Hinman to Capt. W. H. Bixby on August 11, 1886. No work before October, 1886, for want of funds. Owing to the difficulty and expense of properly specifying it beforehand, and measuring and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

One United States hoister (half owned by Contentnia improvement) was in use during the year. Work was confined to the middle portion of the river from 7 miles above to 3 miles below Greenville, where navigation was most obstructed. During portions of October and November a careful survey was made of all those portions of the river (39,000 linear feet) where jetties had formerly been constructed, in order to see the past effect of these jetties, and what modifications they might need. All the jetties (whether of log and brush or of piles and plank) which were originally properly located appear to have done necessary and useful work; but a very few apparently improperly located jetties appeared to need removal, and were removed during the latter part of the year with apparently good results. Between October 1, 1886, and June 30, 1887, and from 7 miles of river near Greenville, 88 large stumps, 571 small stumps, 31 trees, 747 large logs, 500 small logs, 803 large snags, 13 cords of small snags, 2 old flat-boats, and 183 old jetty-piling were removed from the river channel; and 561 overhanging trees (cut down), 145 other trees (pulled back), and 145 cords of brush were removed from the edge of the river bank, so as to leave a clear channel of at least 60 feet width and 2.5 feet depth at dead low water at these points. Work had to be suspended each month for about ten days on account of freshets. A water-gauge record was kept during the year.

All the above work has been well and vigorously carried forward under the immediate supervision of Assistant Engineers John D. Whitford and E. D. Thompson.

Recomendations for future work are as follows: That this improvement be completed in accordance with the present proposed and approved project, so as to secure a thoroughly cleared 9 foot navigation at low water up to Washington, a similar 3 foot navigation at low water up to Greenville, and thence a similar channel during eight months of the year up to Tarborough, at a total expense of $17,000 in addition to the funds available June 30, 1886; this amount to be appropriated in yearly installments of $15,000 till finished. Smaller appropriations will increase the cost by from $1,000 to $4,000 per year. Further improvement, so as to extend this navigation above Tarborough or to make the river above Greenville navigable all the year round, is not recommended at present.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Fifteen thousand dollars for work above Washington, to repair and supplement existing jetties, to remove sunken logs and snags, and to cut down and pull back from caving banks the trees which would otherwise soon fall into the river; the entire length of river to be worked over each year.

This river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1886, amount available		$48.67
Amount received from sale to Contentnia Creek		2,169.69
Amount appropriated by act approved August 5, 1886		5,000.00
		7,218.36
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,969.70	
July 1, 1887, outstanding liabilities	361.27	
		5,330.97
July 1, 1887, amount available		1,887.39
Amount (estimated) required for completion of existing project		17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., July 13, 1887.

CAPTAIN: I have the honor to submit the following report of work done under my charge on Tar River, North Carolina, during the fiscal year ending June 30, 1887:

In accordance with your letter of instructions of October 13, 1886, detailed examinations and surveys were made of such portions of the river as contain jetties between Centre Bluffs and a point 1,000 feet below Hardee's Creek. They were based on compass directions and chain distances, soundings being taken every 20 feet on section lines 200 feet apart, with three extra sections in the vicinity of each jetty; section stakes were so driven as to be permanent for several years, and allow comparative surveys to be made hereafter, the object to be attained being the effects of the existing jetties on the channel.

Above Greenville five systems of jetties were so examined, while from Greenville Bridge to Hardee's Creek the survey was continuous. The contour map submitted in December, 1886, showed fully the results of the work, and indicated modifications to be made in existing systems, so as to secure an improved channel-way of 3 feet depth at low water. The surveys were finished November 15, 1886, the amount expended for field work up to that date being $239.10.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

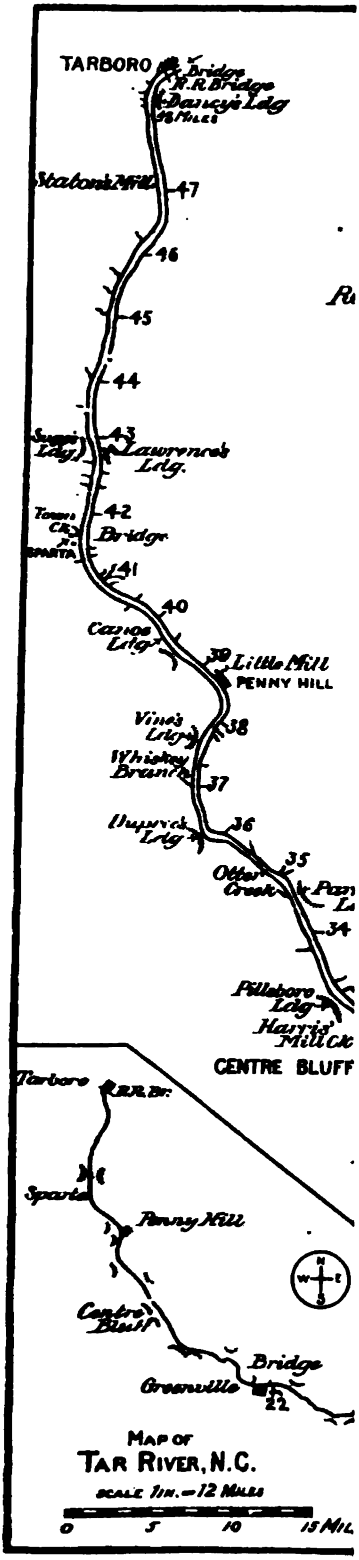
COMMERCIAL STATISTICS.

When work commenced in 1876 this river was irregularly navigated by 3 foot draught steamers up to Tarborough. The commerce is estimated to have then been about $500,000 per year.

At present ten steamers ascend the river 37 miles to Washington, and two run regularly 23 miles more to Greenville during the whole year and 26 miles further still to Tarborough during the flush-water season, carrying about $2,300,000 of goods per year.

The rates of present freights are estimated at from 12 to 25 per cent. less than in 1876.

The commerce is rapidly increasing. Each dollar so far spent on this improvement has been accompanied by the development of about $32 of annual commerce. Washington has developed rapidly, and since 1882 the value of its taxable property has increased 25 per cent. Greenville has increased from 912 inhabitants and $266,000 real estate in 1880 up to 2,500 inhabitants and $600,000 real estate at present. The development of these towns is almost entirely due to the governmental improvement of the river since 1876. It is estimated that the continuation of the present improvement will be followed by a continuation of this rapid development of the neighborhood.


TARBORO
Bridge
R.R. Bridge
Darcy's Ldg
48 Miles
Staton's Mill
47
46
45
44
Sugar Ldg.
43
Lawrence's Ldg.
Town Ck.
42
Bridge
SPARTA
41
40
Canoe Ldg
39 Little Mill
PENNY HILL
Vine's Ldg
38
Whiskey Branch
37
Dupree's Ldg
36
35
Otter Creek
Pan
L
34
Pillsboro Ldg
Harris' Mill Ck
CENTRE BLUFF
Ri
Tarboro
R.R. Br.
Sparta
Penny Hill
Centre Bluff
Bridge
Greenville
22
N
W
E
S
Map of
Tar River, N.C.
Scale 1 in. = 12 Miles
0
5
10
15 Mil

The commerce for the year ending December 30, 1886, is estimated as follows:

	Tonnage.
Foreign and coastwise:	
Making regular trips, 10 steamers	4,000
Making irregular trips (?) sail-boats	23,000
	27,000

Articles.		Quantity.	Amount.
Cotton	bales	32,298	$1,291,520
Potatoes	barrels	4,727	7,090
Naval stores	do	4,845	9,690
Cotton-seed oil	do	81	1.620
Wine	do	30	1,500
Rice, cleared	do	20	600
Rice, rough	bushels	66.449	39,869
Peanuts	do	5,100	5,100
Eggs	packages	2,054	12,324
Truck	do	157	414
Balusters	number	81,400	11,480
Shingles	do	3,222,000	12,888
Staves	do	118.000	17,000
Lumber	feet	36,598,800	365.988
Lumber (juniper)	do	275,000	9,600
Fertilizers	tons	3,400	88,400
General merchandise	do	9,816	450,800
Passenger fares (on river steamers)	number	7,200	10,820
Total			2,336,703

M 2.

IMPROVEMENT OF CONTENTNIA CREEK, NORTH CAROLINA.

(For special history of past work, see page 975 Annual Report for 1886.)

Contentnia Creek, a tributary of the Neuse River, has a total length of about 144 miles, and a drainage area of 1,184 square miles. This creek, prior to governmental improvement in 1881, had a depth of about 3 feet during nine months of the year, from its mouth in the Neuse upward, about 63 miles, to Stantonsburg, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps and by floating obstructions. Its steamboat commerce was nothing.

The original project of 1881, as continued to date, proposed for $40,000 to secure a safe and unobstructed 3-foot navigation over this entire distance during the high-water season of about nine months. This estimate was based on an examination required to be made in great haste, at slight expense, and during a time of high freshet. The estimate supposed the obstructions to be about seventeen sunken trees and one stump per mile, but actual work later showed an average of more than forty-five sunken trees and forty-five stumps per mile. A personal examination of the river over its entire length (made as soon as possible by me after assuming charge in 1884) revealed these facts, and moreover showed me the agricultural richness of the river basin, its urgent need for better transportation facilities, and the worthiness of the improvement. Moreover, inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons, the estimates for the final cost of the work were raised in 1885 to $75,000, and now (1887) to $78,000. The aggregate amount appropriated for this project up to June 30, 1887, is $40,000.

Thirty-four thousand, nineteen dollars and nine cents has been spent in all upon this improvement up to June 30, 1887, in securing a roughly cleared 3 foot navigation over the 31 miles from its mouth up to Snow Hill during the high-water season. In consequence of this, a steamboat line has been permanently established upon the whole length thus improved, and two steamboats have made biweekly trips during nearly nine months each year, to the great benefit to the neighboring country, otherwise without transportation facilities for its products. Furthermore, a commencement has been made upon the opening of the river above Snow Hill. The present commerce (including rafted goods) is rapidly increasing, and is at present about $600,000 of goods transported per year, showing that each dollar spent on the improvement has been accompanied by the development of $17 in annual commerce. The latest reliable commercial statistics, those of the year ending December, 30, 1886, are herewith appended.

The navigation of this river is obstructed at points as shown by the following extract from special report dated December 18, 1886:

> Between Stantonsburg, the head of present improvement, and Snow Hill, the head of present navigation, there are three county bridges without draws, but there has as yet been no navigation demanding draws. When needed, the draws will undoubtedly be put in by the county authorities. I therefore recommend that these bridges be permitted, for the present, to remain in their present condition, provided that their owners will insert suitable draws therein whenever needed by steamers.

The special work of the year is as follows: Expenditures, $9,331.40; value of United States plant, $5,000. No work prior to October, 1886, for want of funds. Two small steam-hoisters in use during portion of year. Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterward, the work was allowably done by hired labor and the purchase of materials in open market.

Between the last of October, 1886, and June 30, 1887, and from the 31 miles of river below Snow Hill, 102 large snags, 14 cords small snags, 264 large stumps (hoisted), 317 large stumps (blasted), 750 logs, and 115 cubic yards mud were removed from the river bed; 513 floating logs were removed from the channel, and 403 large trees; 225 cords of brush were cut and pulled back from the edge of the river banks, so as to secure the proposed channel up as far as Snow Hill. Work was also begun above Snow Hill. High water prevented work a few days each month. Near the mouth of the river 825 cubic yards of earth were piled on the up-stream side of a small log dike at the head of Spring Slough, so as to complete it to 384 feet length, 4 feet thickness at top, and 10 feet thickness at bottom, this dike being built to prevent the water from wasting into the adjacent swamp at low water.

Two small steam-hoisters, two quarter-boats, four small decked flats, and five small skiffs were built on the works during the first part of the season.

A water-gauge record was kept during the working season.

A careful inspection of property was made at the end of the year.

All the above work has been well and vigorously carried forward under the immediate supervision of Assistant Engineers R. Ransom and J. D. Whitford.

Recommendations for future work are as follows: That this improvement be completed in accordance with the present proposed and approved project, so as to secure a thoroughly cleared 3 foot navigation over the entire river from its mouth 63 miles upward to Stantonsburg during the nine commercial busy months of the year, at a total expense of $37,500 in addition to the funds available June 30, 1887; this

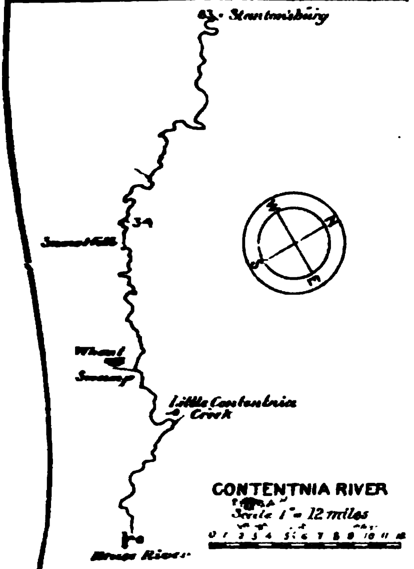
MAP

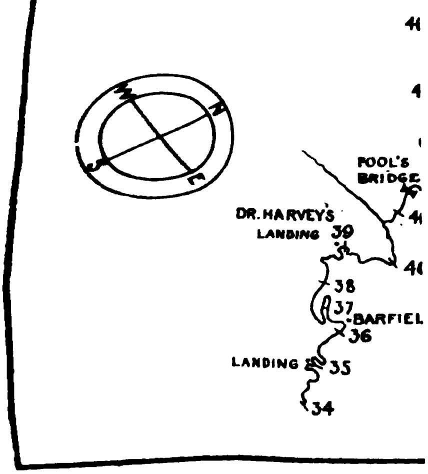
CONTENTNIA

MOUTH TO STA

Scale 1÷

Surveyed by Reic
1881, under direct
PHILLIPS, Corps of E
Reduced in Office
by Chas. Humph





amount to be appropriated in yearly installments of $30,000 until complete. Smaller appropriations will increase the cost by from $1,000 to $4,000 per appropriation. Further improvement, so as to extend this navigation above Stantonsburg, or so as to make any part of the river navigable during the low-water season, is not recommended at present.

After the improvement is finished, its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Fourteen thousand dollars to secure a fairly cleared natural channel for steam navigation from Snow Hill 32 miles upward to Stantonsburg, by removing all dangerous obstructions, such as sunken logs and snags, and by cutting down and pulling back from caving banks the trees which would otherwise soon fall into the river. The extension of navigation to Stantonsburg will open up the richest part of the Contentnia Basin, and will greatly increase the river commerce.

Ten thousand dollars to dredge and dike the natural channel in its "narrows" and near the river's mouth, so as to keep the water from running off into the adjacent swamps.

Thirteen thousand five hundred dollars to clear the entire river thoroughly of all remaining obstructions to its free navigation during the nine commercially busy months of the year.

This river is in the second collection district of North Carolina.

Money statement.

July 1, 1886, amount available		$312.31
Amount appropriated by act approved August 5, 1886		15,000.00
		15,312.31
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$8,623.22	
July 1, 1887, outstanding liabilities	708.18	
		9,331.40
July 1, 1887, amount available		5,980.91
Amount (estimated) required for completion of existing project		37,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., July 1, 1887.

CAPTAIN: I have the honor to make the following report of operations upon Contentnia Creek during a short time of the past fiscal year.

On October 28, 1886, a small force was put to work a short distance above the mouth of Contentnia Creek, first, to build an earth dam or dike from the head of Spring Slough to the high ground south. The length is 384 feet. The base has a minimum width of 10 feet, with an average height of 4 feet, and is 4 feet wide on top. It is level its whole length on top. The dam was completed on the 20th of November. At the creek end it is faced with 2-inch short piles, and the work is well done, the whole dike having been compactly rammed. Next, Spring Slough was *partially* cleared over its whole length to 30 feet width, and 120 stumps, 40 large logs, and 14 cords of snags were taken out. Twenty-two large trees were cut from the banks, and 600 feet of bank cleared of small growth. This piece of work was far from complete, though, with a comparatively small additional work at head of slough, boats could navigate the slough. During the fall, estimates for a light working plant were submitted and approved, and materials procured by the 1st of December to begin work building the plant. On that day I transferred the charge of the work to J. D. Whitford, assistant engineer.

The expenditures for the year while in my charge were	$452.09
Superintendence and labor	443.59
Material (12 shovels)	9.50
The cost of building the dam was, by close approximation	295.00
Work upon Spring Slough, by close approximation	148.59

The work was done mainly with implements and flats borrowed from the Neuse River plant.

Very respectfully, your obedient servant,

R. Ransom,
Assistant Engineer.

Capt. W. H. Bixby,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1881 the steam-boat commerce was nothing and its rafting commerce insignificant; and the products of the neighborhood had to be hauled overland long distances to market.

At present four steam-boats enter this river, of which two stop near its mouth, and two run 30 miles up the river to Snow Hill during nearly nine months of the year, carrying over $600,000 of goods per year.

The rates of present transportation are estimated at from 12 to 50 per cent. less than those of the former transportation. The marine insurance rates are already light.

The commerce is rapidly increasing. Each dollar so far spent on this improvement has been accompanied by the development of $17 of annual commerce. Bell's Ferry, 4 miles from the river mouth, has increased from one store, a few houses, and thirty-seven inhabitants in 1880 up to thirty-seven stores and houses, several churches, mills, and school-houses, about 200 inhabitants, and a commerce of about $200,000. Snow Hill, 31 miles from the river mouth, has increased from 332 inhabitants in 1880 up to about 500 inhabitants. In both towns the property has increased in like proportion. It is estimated that the extension of navigation 33 miles farther to Stantonsburg will open up the richest part of the Contentnia Basin, and will more than double its present commerce.

The commerce of the year ending December 30, 1886, is estimated as follows:

Articles.		Quantity.	Amount.
Cotton	bales	8,500	$340,000
Rice	bushels	30,500	18,300
Fertilizers	tons	1,350	35,100
General merchandise	do	4,800	240,000
Peanuts	bushels	3,000	3,000
Fish (fresh)	packages	150	750
Oysters	do	150	750
Fish (salt)	barrels	300	1,500
Live stock	number	15	150
Total		....	639,550

M 3.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

(For special history of past work, see p. 978, Annual Report of 1886.)

Trent River, a tributary of the Neuse River, has a total length of about 73 miles, and a drainage area of 657 square miles. This river in 1879, at the time when placed under governmental improvement, possessed a 6-foot to 8-foot roughly cleared navigation from its mouth at New Berne up 21 miles to Pollocksville, and a lighter-draught navigation 9 miles further to Quaker Bridge. Above Pollocksville the bars, snags, and trees prevented all navigation, except occasionally by small flat-boats during high freshets.

Its commerce is estimated to have been about $400,000 of goods per year.

The original projects of 1879 to 1880, as continued to date, assumed that 6 to 8 feet of water could be carried at all stages from its mouth 21 miles to Pollocksville, and proposed for $22,000 to secure a thoroughly cleared 3-foot navigation, with at least 50 feet channel width at all stages of water, from Pollocksville 22 miles up to Trenton, the practicable limit of steamboat navigation, using the balance of the funds to improve the channel from its mouth 30 miles upwards to Pollocksville and Quaker Bridge.

This estimate was based on an examination required to be made in great haste and at slight expense. The estimate as regards sunken obstructions in the upper 14 miles of river supposed only 25 stumps and logs per mile, whereas an average of more than 250 per mile were actually found. A personal examination of the river over its entire length (made by me as soon as possible after assuming charge in 1884) revealed these facts, and, moreover, showed me the agricultural richness of the river basin, its need of better transportation facilities, and the worthiness of the improvement. Moreover, inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons, the estimates for the final cost of the work were raised in 1885 to $57,000, and now (1887) to $59,000. The aggregate amount appropriated for this project up to June 30, 1887, is $45,500.

Forty-two thousand, thirty-one dollars and seventy-three cents has been spent in all upon this improvement up to June 30, 1887, in securing a moderately well-cleared 6-foot to 8-foot navigation at all stages (8 to 9 feet at ordinary stages) from New Berne 30 miles up to Quaker Bridge, and thence a thoroughly cleared 3-foot navigation, at least 50 feet wide at all stages, 13 miles further to Trenton, and an excellent turning-basin at Trenton. In consequence of this improvement a steamboat navigation has been permanently established over the entire river to Trenton, with weekly trips in summer and tri-weekly trips in the busy seasons of winter. The commerce is still increasing, and is now about $650,000 of goods transported per year (including rafted goods), showing that each dollar spent on this improvement has been accompanied by the development of about $6 of annual commerce. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The navigation of this river is not obstructed by bridges without draws.

The special work of the year is as follows: Expenditures, $567.67; value of United States plant, $15,700. No work done before October, 1886, for want of funds.

Owing to the difficulty and expense of properly specifying it beforehand, and inspecting and measuring it afterwards, the work was allowably done by hired labor and purchase of materials in open market. The most important work to be done was that of dredging and blasting at Foy's Flats. Attempts were made all during the year to hire the dredging, but the amount of funds available for this work was so small that nothing could be obtained at any terms advantageous and economical to the United States. Consequently further work awaits further appropriations. While so waiting, seven logs and six trees were re-

At present steamers make regular semi-weekly trips in summer, and tri-weekly or daily trips in the busy season of winter, going 43 miles up the river to Trenton, carrying about $650,000 of goods per year.

The rates of present transportation are estimated at from 25 to 75 per cent. less than those in 1879, and the marine insurance is now considered unnecessary.

The commerce is increasing. Each dollar so far spent upon the improvement has been accompanied by the development of about $6 of annual commerce. It is estimated that prospective benefits are in proportion to those of the past. Half of the river basin is without railroad transportation, and must depend upon the river for its future development.

No detailed account of the commerce of the river could be obtained from the steamboat companies.

The commerce for the year ending December 30, 1886, is estimated as follows:

Cotton (8,300 bales)	$332,000
General merchandise (lumber, potatoes, cotton-seed, truck, hay, salt, lime, flour, machinery, fertilizers)	318,000
	650,000

M 4.

IMPROVEMENT OF THE NEUSE RIVER, NORTH CAROLINA.

(For special history of past work, see p. 982 Annual Report of 1886.)

Neuse River, entering into the Pamlico Sound, has a total length of about 360 miles and a drainage area of 5,781 square miles (2,506 of which are situated above the mouth of its upper main tributary, the Contentnia). This river, when placed under governmental improvement in 1878, possessed during nine months of the year a 9-foot depth of channel from its mouth 40 miles up to New Berne, thence a 4-foot depth 50 miles further to Kinston, thence a 3-foot depth 46 miles further to Goldsborough, and thence a 2-foot depth 62 miles further to Smithfield, this channel depth being reduced during the low-water season to 8 feet at New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the whole 198 miles the river was so blocked by war and other obstructions that navigation was impracticable. Its steam-boat navigation was therefore almost nothing.

The original projects of 1871 for below Goldsborough, and of 1879 for above Goldsborough, contemplated for $174,000, in all, the removal of the war blockades and natural obstructions (only 6,000 logs and snags) and the excavation of a few cut-offs, so as to get 4½ feet at low water all the year to Goldsborough, and 3 feet during nine months to Smithfield. However, over 16,000 logs and snags had to be removed, and over 5,000 linear feet of logs and brush jetties, and 43,000 linear feet of plank jetties, have had to be constructed to give only a portion of the originally projected improvement, so that the original estimates have since had to be largely increased. A personal examination of the river (made by me as soon as possible after assuming charge in 1884) revealed the necessity for so much work, and moreover showed the agricultural richness of the river basin, its need of free transportation facilities, and the worthiness of the improvement. The projects of 1878, 1880, and 1883, as continued to date, propose to remove all sunken logs, snags, floating and other obstructions, and to contract the channel-way by jetties so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston, and during nine months of the year a 3-foot navigation 108 miles further to Smithfield. Besides the first insufficient estimates, I find that inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons the estimates for the final cost of this work were raised in 1885 to $370,000 and now (1887) to $374,000. The aggregate amount appropriated for these projects up to June 30, 1887, is $232,500.

Two hundred and twenty thousand and forty dollars and thirty-eight cents have been spent in all upon this improvement up to June 30, 1887, giving a moderately well-cleared channel over the entire length of the river, allowing an 8-foot navigation 40 miles to New Berne and a 3-foot navigation 50 miles further to Kinston all the year; also, a fair 3-foot navigation 46 miles further, to Goldsborough, during nine months per year, and still 62 miles further, to Smithfield, six months per year. In consequence of this, two steam-boat lines have been permanently established between New Berne and Kinston, and the river commerce has increased from almost nothing up to over $1,800,000 of goods transported per year, showing that each dollar spent on this improvement has been accompanied by the development of about $8 of annual commerce. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The navigation of this river is obstructed at points, as shown by the following extract from special report dated December 18, 1886:

> Near Kinston this river is crossed by the Atlantic and North Carolina Railroad on a draw-bridge, whose draw-span is placed upon the shallow side of the river instead of over the main channel-way. The present improvement will probably be so far finished in 1887 as to permit of a deeper navigation above this bridge at Kinston than will then be able to pass through this draw-opening. All the steamer captains whom I have so far heard from state that they have not as yet been delayed from want of water at this draw-opening, and I do not see any reason for a change in the position of the draw before 1887. I therefore recommend that this draw may be permitted to remain in its present position for the present, but that it be moved to the channel side of the river as soon as it becomes the chief serious obstruction to a permanently increased depth of navigation between New Berne and Kinston.
>
> Near Goldsborough this river is crossed by the Wilmington and Weldon Railroad, on a single-span bridge without a draw. The bottom of the bridge is about 17 feet above low water. The channel is said to be partially obstructed by a pier of the former bridge. Very few steamers have so far reached this bridge, although the river is navigable for several miles above Goldsborough. I therefore recommend that this bridge be permitted for the present to remain in its present condition, provided that the owners will clear away the obstructing portion of the old pier beneath, and provided also that they will furnish a suitable hinge-joint to the smoke-stacks of all steamers using regularly this portion of the river.
>
> Above Goldsborough and below Smithfield there are six county bridges without draws, but there has as yet been no navigation demanding draws. When needed, the draws will undoubtedly be put in by the county authorities. I therefore recommend that these bridges be permitted for the present to remain in their present condition, provided that their owners will insert draws therein whenever needed by the steamers.

The special work of the year is as follows: Expenditures, $14,214.66; value of United States plant, $5,480. Three United States steam-hoisters were in use during the working season. No work done before October 10 on account of high water.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work (except the purchase of lumber) was allowably done by hired labor and the purchase of materials in open market.

The stage of water allowed jettying only one month during the year (from October 10 to November 10). During this time, and over 2 miles of river from 27 to 30 miles above New Berne, eight unfinished and thirteen new pile and plank jetties (1,767 linear feet) were completed in place. As soon as jettying was stopped, snagging and clearing banks was commenced. Between December 10 and June 30 the river was re-examined and recleared from Bull Point, 30 miles above New Berne, 50 miles upward to near White Hall, 28 miles above Kinston. In this way 1,347 logs, 334 trees, 1,631 stumps (hoisted), 88 stumps (blasted), 2,939 large snags, 161 cords small snags, 235 linear feet old undermined jetties, and 225 old bank-protector piles were removed from the river channel; and 810 logs (rolled back), 16 stumps, 96 trees (trimmed), 2,012 trees (cut and pulled back), and 35 cords small brush were removed from 91,913 linear feet of river-bank. This work was interfered with by freshets in March and April.

During the year, one hoister was entirely rebuilt, with new scow and new engine and boiler, and the other was supplied with a new scow, one old engine and scow being retained for occasional use on the work.

A water-gauge record was kept during the year.

A careful inspection of property was made at the end of the year.

The completion of a thoroughly cleared 4-foot channel from New Berne to Kinston will require further jettying over 1.5 miles of river, the removal of many snags, logs, and trees from the bed of the river, and the removal or repair of some old jetties.

This work will be pushed forward rapidly during the coming high-water season, and carried as far as the present funds will permit.

All the above work has been well and vigorously carried forward under the immediate supervision of Assistant Engineer R. Ransom, whose report is herewith appended.

Recommendations for future work are as follows: That this improvement be completed in accordance with the present approved and adopted projects, so as to secure a thoroughly cleared 9-foot navigation 40 miles, up to New Berne, and a similar 4-foot navigation 50 miles further, to Kinston, during the entire year, and thence a similar 3-foot navigation 108 miles further, to Smithfield, during nine months of the year, at a total expense of $141,500, in addition to the funds available June 30, 1887, this amount to be appropriated in yearly installments of about $60,000 each.

Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant will increase the cost of the work by from $2,000 to $6,000 per appropriation. Further improvement, so as to extend the navigation above Smithfield, or so as to increase the depth of water or length of time of such navigation below Smithfield, is not recommended at present.

After the improvement is finished, its proper maintenance may cost from $2,000 to $6,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately, as follows:

Twenty-one thousand five hundred dollars to secure an unobstructed channel of 3 feet depth at low water from New Berne 50 miles upwards to Kinston, by completing the present work of contraction of the river channel.

Twenty thousand dollars to secure a thoroughly cleared natural channel from Kinston 108 miles upwards, to Smithfield, by removing all sunken logs and snags, and by cutting down and pulling back from caving banks the trees which would otherwise soon fall into the river.

Twenty thousand dollars to increase the channel depth from New Berne to Kinston to 4 feet at low water by dredging and jettying.

Eighty thousand dollars to increase the channel depth from Kinston to Smithfield to 3 feet during nine months of the year by dredging and jettying.

This river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1886, amount available		$4,174.28
Amount appropriated by act approved August 5, 1886		22,500.00
		26,674.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$12,873.41	
July 1, 1887, outstanding liabilities	1,341.25	
		14,214.66
July 1, 1887, amount available		12,459.62
Amount (estimated) required for completion of existing project		141,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing lumber, iron, and nails for improving Neuse River, North Carolina, opened at 12 m., July 14, 1886.

No.	Names and addresses of bidders.	Price.	Remarks.
1	J. C. Whitty, New Berne, N. C.	No bid for lumber, 6 cents per pound for iron, $2.70 per keg for nails.	Proposal to furnish iron and nails.
2	B. W. Canady, Kinston, N. C.	$13.50 per M for lumber, 5 cents per pound for iron, $2.75 per keg for nails.	Proposal to furnish all.
3	M. H. Carr and J. H. White, Cobton, N. C.	$15 per M for lumber. No bid for iron and nails.	Proposal for 25,000 feet lumber only. No bid for iron and nails.

Contract with B. W. Canady.

Abstract of proposals for building two scows, with hoisters, opened at 12 m., July 30, 1886.

No.	Names and addresses of bidders.	Price.	Remarks.
1	Fred. Ferebee, Portsmouth, Va.	$3,282	Proposal for the two, delivered in ninety days from date of contract.
2	Samuel W. Skinner, Wilmington, N. C	2,350	Proposal for both.

Rejected; price too high. Built by hired labor and purchase of materials in open market.

Abstract of proposals for furnishing a hoisting engine for the improvement of Neuse River, North Carolina, opened at 12 m., January 8, 1887.

No.	Names and addresses of bidders.	Price.	No.	Names and addresses of bidders.	Price.
1	George L. Neville, Portsmouth, Va.	$1,225	3	E. J. Codd & Co., Baltimore, Md.	$1,215
2	Lidgerwood Manufacturing Company, New York, N. Y.	1,214	4	J. S. Mundy, Newark, N. J.	1,050

Contract with J. S. Mundy.

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., June 30, 1887.

CAPTAIN: I have the honor to submit the following report of operations upon Neuse River for the fiscal year ending the 30th of June, 1887:

Total expenditures under my orders	$12,581.63
Divided as follows:	
Pay-rolls	7,926.92
Materials	3,223.75
Rations	1,199.51
Office rent, etc	113.20
Travel expenses	118.25

Superintendence, care of property, and office expenses, previous to October, 1886, $827.93.

Active work was resumed the 10th of October, 1886, as soon as the water in the river was low enough for advantageous work.

During October and November 1,767 linear feet of jetties were put in, beginning with jetty 55½, as marked upon blue print for Deer Neck and below. Nos. 55½ and 58½ were begun and finished in 1886–'87; 62 to 69 were begun in 1885, but completed in October, 1886; Nos. 70 to 80 were begun and completed in 1886–'87; making a total as above. The cost of this 1,767 feet of jettying was:

Labor, rations, and superintendence	$946.31
Materials (40,956 feet lumber, $552.90; iron and nails, $16.62)	569.52
Making total of	1,515.83

By the 10th of November, 1886, the water was too high for further jettying, and snagging and clearing banks was begun, going up-stream from Bull Point.

From Bull Point, about 22 miles to Kinston, 235 feet of old jetties, 561 logs, 542 stumps, 745 snags, 82 cords small stuff, and 225 old bank-protector piles were withdrawn from the stream, and 16 stumps cut off; 542 trees cut and pulled back, 71 trees trimmed; 12 cords of brush cut, and 7 logs rolled back, constituted the bank work over the same distance; 21,165 feet bank cleared. The cost of this was $2,368.74.

Above Kinston snagging and clearing banks continued to June 30, and from Kinston to within a mile of White Hall, over about 28 miles of river, 786 logs, 1,089 stumps, 2,194 snags, 78.50 cords of small stuff, and 334 trees were taken from the stream; 88 of the stumps required blasting; 559 large and 911 small trees were cut and pulled back, 25 trees trimmed, 25.5 cords of brush cut, and 803 logs rolled back, and 70,748 feet of bank cleared was the work done on the banks.

The cost of all work from Kinston to highest point reached during the year was $4,538.33.

In the fall and winter two scows, to replace the old ones, for hoisters were built at a total cost for the two of $1,550.70, detailed statements of which have been furnished.

It was deemed advisable to place a new engine and boiler upon one of the new scows, which cost $1,050.

Expendable material bought and not applied in construction, but on hand and used during year's operations, $730.10.

The foregoing is as nearly an exact statement of cost and expenditures as it is practicable for me to make. The cost of a linear foot of jetty was about 85 cents. To determine the cost of removing every tree, log, stump, snag, etc., is not exactly practicable, but an approximation is submitted, which is believed to be a very close average:

Trees taken from the stream (each)	$1.50
Large logs taken from the stream (each)	.75
Large stumps taken from the stream (each)	.75
Large snags taken from the stream (each)	.50
Cords of small stuff taken from the stream (each)	2.50
Large trees cut and pulled back on bank (each)	.75
Small trees cut and pulled back on bank (each)	.25
Logs rolled back on bank (each)	.05
Trees trimmed (each)	.30
Stumps blasted (each)	.60

The width of the river varies from 150 to 300 feet, and its depth from five-tenths of a foot to 15 feet.

Tide gauges are fixed at various points, notably on bridges, and a daily record of the tide has been kept.

The jetties have been under water since 10th of November, 1886, and only conjecture can be given as to their condition. It is feared they may have suffered considerably, as many of them needed attention from former injury.

One of the old scows was retained with its engine and boiler for the purpose, mainly, of using upon it a drive-pump for sinking piles.

Much of the plant and material is worthless, as your recent inspection showed. This is owing simply to natural decay and ordinary usage.

Mr. Herman Bryan, overseer, a young man who has grown up with the work from the position of laborer, has controlled the labor and carried on the actual work. The amount done, the economy of its execution, together with its thoroughness, shows his fitness for his position, and I gladly commend him and the other employés for their cheerful and faithful service.

The commerce over the river has on the whole somewhat increased since last annual report, though the item of rice is materially reduced.

Appended are statistical tables obtained from most reliable sources.*

The steam-boats that have for some years plied the stream continue their business, and two others of more modern model and greater capacity will be placed upon it the coming autumn.

The character of the stream, of the country bordering it, and the propriety of the early completion of the project for its improvement need no repetition from me.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1878, all navigation was restricted to one small steamer, which ran irregularly during the high-water season, carrying about 2,000 bales of cotton per year ($80,000).

At present five steamers run regularly 50 miles up to Kinston, and irregularly 46 miles further to Goldsborough, carrying about $1,800,000 of goods per year.

The rates of present transportation are estimated at from 25 to 75 per cent. less than in 1878 (75 cents per bale now by steamer when it was formerly $2.75 per bale by wagons). The rate of insurance has fallen from 25 to 33 per cent., and marine insurance is now deemed unnecessary in the river above New Berne.

The country in the neighborhood is rapidly developing under the influence of better transportation facilities. Each dollar so far spent upon this improvement has been accompanied by the development of about $8 of annual commerce. It is estimated that prospective benefits are in proportion to those of the past. Half of the river basin is without railroad transportation and must depend upon the river for its future development.

The effects of the improvements of the Neuse, Trent, and Contentnea rivers is best shown by the commerce of New Berne, their port of entry. Its cotton receipts have increased from 12,000 bales in 1878, to 51,000 bales to-day; the lumber from 1,000,000 feet then, to 10,000,000 feet now; the rice from nothing then, to 70,000 bushels now; the truck from 2,000 packages then, to 160,000 packages now.

The commerce of the Neuse River, separate from that of New Berne, could not be obtained in detail from the steam-boat companies. Its commerce for the year ending December 30, 1886, is, however, roughly estimated as follows:

Articles.	Quantity.	Amount.
Cotton .... bales..	27,420	$1,096,800
Corn .... bushels..	130,000	104,000
Oats .... do....	53,000	42,000
Peas .... do....	4,500	4,500
Lumber .... feet..	9,000,000	63,000
General merchandise and fertilizers	....	500,000
Total	....	1,810,300

New Berne is the port of entry of the Neuse, Trent, and Contentnea rivers; and its commerce must be considered as pertaining in part to all of them. The commerce is carried on by five small steamers up the rivers to Trenton, Kinston, and Snow Hill, and by three large steamers along the coast to Elizabeth City, Norfolk, and Baltimore. The custom-house reports its commerce for the year ending December 30, 1886, as follows:

---

* Omitted.

	No. of vessels.	Tons.	Amount.
Entered from foreign ports	2	155	$758.44
Cleared for foreign ports	2	155	2,547.50
Entered from coastwise ports	213	95,400	....
Cleared from coastwise ports*	....	....	....
Value of domestic exports	....	....	3,500,000.00
Total	....	....	3,503,305.94

*No record.

Value of dutiable imports	$756.17
Amount of duty collected	358.62

Other estimates for both exports and imports of New Berne for 1886 are as follows:

Articles.		Quantity.	Amount.
Cotton	bales	51,300	$2,052,000
Lumber	feet	10,000,000	70,000
Shingles	number	35,000,000	17,500
Truck	packages	160,000	320,000
Corn	bushels	250,000	150,000
Rice (rough)	do	70,000	70,000
Rice (cleaned)	tierces	100	2,000
Naval stores	barrels	6,000	6,000
Wood plates	pieces	8,000,000	10,500
Wood pulp	packages	1,100	....
Cotton seed	tons	1,300	13,000
Cotton-seed meal	do	400	10,000
Cotton-seed oil	barrels	500	7,500
Fish (fresh)	tons	1,250	65,000
Fish (salt)	barrels	2,000	9,000
Fish scrap	tons	1,500	1,500
Coal	do	4,400	17,600
Ice	do	1,200	12,000
Bacon and pork	pounds	3,550,000	330,000
Fertilizers	tons	5,500	160,000
General merchandise	do	10,000	1,000,000
Total		....	4,324,600

M 5.

IMPROVEMENT OF THE LINE OF INLAND NAVIGATION AND INLAND WATER-WAY FROM NEW BERNE TO BEAUFORT HARBOR, NORTH CAROLINA, VIA CLUBFOOT, HARLOWE, AND NEWPORT RIVERS.

(For special history of past work, see page 985, Annual Report of 1886.)

The inland line of navigation from New Berne to Beaufort Harbor via Clubfoot, Harlowe, and Newport rivers was established in about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned.

This line, about 42 miles in total length, extends from New Berne about 23 miles down the Neuse River, 6 miles up Clubfoot River, 3.21 miles through the Clubfoot and Harlowe Canal, 3.5 miles down Harlowe River, and 6 miles through Newport River to Beaufort Harbor.

Since 1880 the line has been reopened by the New Berne and Beaufort Canal Company, so as to allow in 1885 the passage of small boats of 15 feet width and 3 feet draught. This inland line of navigation via Clubfoot, Harlowe, and Newport rivers was recommended in 1883 as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward; and the cost of a channel 80 feet wide and 9 feet deep was estimated at $883,580, increased by the cost of a tide-lock and the canal company's franchise.

Ten thousand dollars were appropriated in 1882 ($5,000 to be taken from the appropriation for Neuse River, $5,000 from that for Beaufort Harbor) for an inland line of navigation from New Berne to Beaufort Harbor, and it was decided in 1884 that this money was to be spent upon the route via Clubfoot, Harlowe, and Newport rivers.

The adopted project of 1884 for the expenditure of this $10,000 as continued to date, proposed to widen and deepen Harlowe Creek, so as to secure a through canal of 5 feet depth at mean low water, and of 30 feet bottom width from the mouth of Harlowe Creek upward 3.25 miles to its head, and to use the remaining funds upon similar works on Clubfoot River. Work was commenced in 1884, but on account of unexpected obstacles and the small amount of available funds the work had to be suspended until 1886, when more funds were voted by Congress. In 1885 new estimates were submitted, stating $92,000 to be the final cost of a channel 30 feet wide and 5 feet deep at low water from the Neuse River through to Newport River, adapted to the existing navigation of the Neuse River desiring passage by this route to Beaufort Harbor. The aggregate amount appropriated for this project up to June 30, 1887, is $20,000.

Three thousand four hundred and ninety-nine dollars and twenty-five cents has been expended in all upon this improvement up to June 30, 1887, on necessary surveys, in superintendence, in the removal of the worst logs and stumps in the existing channel, and in a commencement of the proposed cutting.

At present about $180,000 of goods are carried through this waterway in small sail-boats. Rates of transportation between New Berne and Beaufort have dropped about 25 per cent. since the improvement has commenced; and each dollar spent upon this improvement has been accompanied by the development of more than $20 of annual commerce. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The navigation of this route is not obstructed by bridges without draws.

The special work of the year is as follows: Expenditures, $1,293.49; value of United States plant, $14.

Dredging was stopped in March, 1885 (by order of the Engineer Department), to await the further action of Congress. By special authority of June, 1886, $800 was allowed for the removal of logs and snags in the creek itself; and in July and August, 1886, 94 logs, 31 snags, 150 stumps (hoisted), 126 stumps (blasted), and 15.5 cords of stump fragments were removed from the creek. After new appropriations were voted for this work, the dredging was contracted for (December 27, 1886), to be completed, with other contracts, before January 31, 1888. The time of commencement of this work was postponed several weeks to allow the contractor to build a dredge especially adapted to this work. Work was begun by him on June 21, 1887, and considerable marsh sod was removed preparatory to the introduction of the dredge. At this time work was temporarily delayed by heavy rains and extreme heats. Work will be rapidly pushed during the next few months. While awaiting the commencement of dredging, the route of the canal was carefully surveyed, located, and proposed work measured up.

Such work as was done has been vigorously and thoroughly carried on under the immediate supervision of Assistant Engineers R. Ransom and E. D. Thompson, whose reports are herewith appended.

Recommendations for future work are as follows: That this improvement be extended in general accord with the projects of 1883 and 1884 over the whole distance through the New Berne and Beaufort Canal, as well as through Clubfoot River and Harlowe Creek, so far as to secure a channel of 5 feet depth at mean low water and 30 feet bottom width from the mouth of Harlowe Creek to the mouth of Clubfoot River, thus completing a 5-foot navigation from New Berne to Beaufort, at a total expense of $72,000, in addition to the funds available June 30, 1887, this amount to be appropriated in one sum. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant, will increase the cost of the work by from $1,500 to $4,000 per appropriation.

A personal inspection of this route (made as soon as practicable after assuming charge in 1884) revealed the worthiness of this improvement. If well opened, this line would be of much value as a connecting link between Pamlico Sound and Beaufort Harbor, and would complete an otherwise already existing inland navigation from the Chesapeake to Beaufort, N. C. The dangers of ocean travel around Cape Hatteras and Cape Lookout are so great that some such 5-foot navigation for small vessels appears necessary between Pamlico Sound and Beaufort Harbor, and no similar navigation can be secured by any other route except at greatly increased expense. Further improvement over this route so as to secure a channel of more than 5 feet depth at low water is not recommended for the present.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Forty thousand dollars to secure a channel of 30 feet bottom width and 5 feet depth through the canal by dredging, and to purchase the franchise of the New Berne and Beaufort Canal Company, thus repaying it for its past expenses of dredging in the canal.

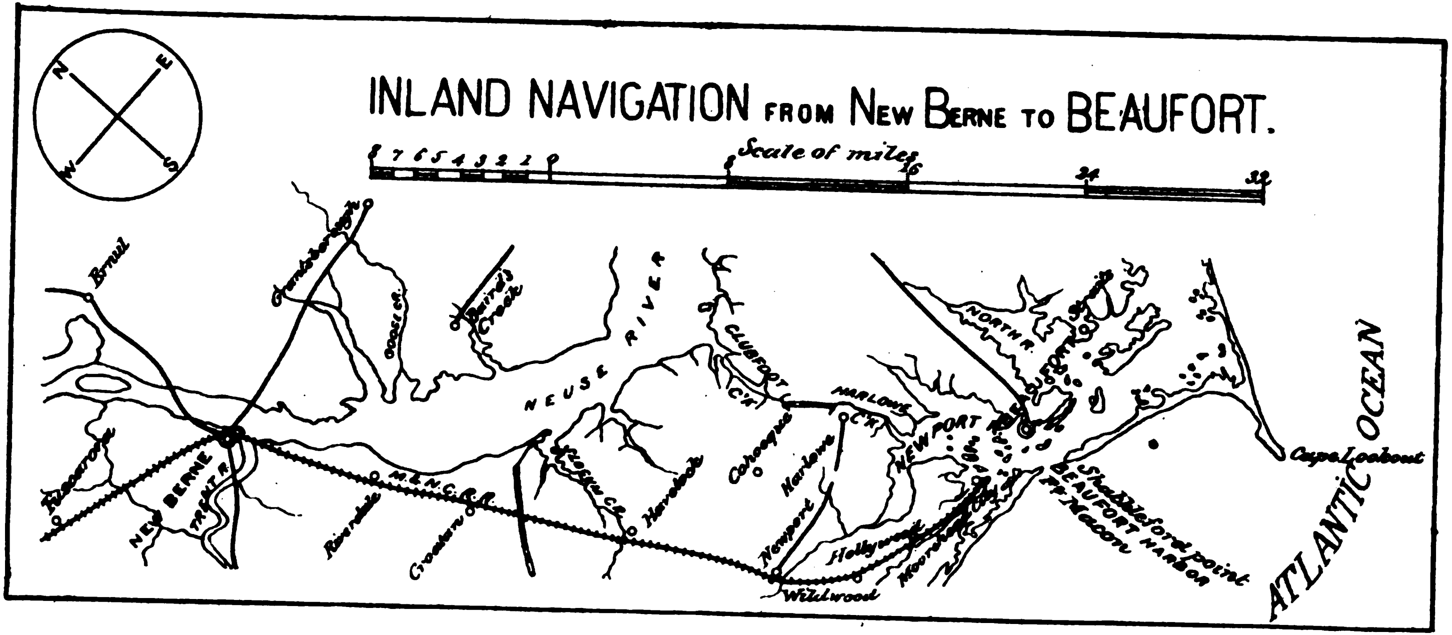
Seventeen thousand dollars to secure a channel 30 feet bottom width and 5 feet deep at low water from the head of Harlowe Creek 3.25 miles downward, to a 5-foot depth at low water in Newport River, by dredging.

Fifteen thousand dollars to secure a similar channel from the head of Clubfoot Creek to the Neuse River, by dredging.

This work is in the collection districts of Pamlico and Beaufort, N. C.

Money statement.

July 1, 1886, amount available		$7,794.24
Amount appropriated by act approved August 5, 1886		10,000.00
		17,794.24
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,257.99	
July 1, 1887, outstanding liabilities	35.50	
		1,293.49
July 1, 1887, amount available		16,500.75



INLAND NAVIGATION FROM NEW BERNE TO BEAUFORT.

months. While awaiting the commencement of dredging, the route of the canal was carefully surveyed, located, and proposed work measured up.

Such work as was done has been vigorously and thoroughly carried on under the immediate supervision of Assistant Engineers R. Ransom and E. D. Thompson, whose reports are herewith appended.

Recommendations for future work are as follows: That this improvement be extended in general accord with the projects of 1883 and 1884 over the whole distance through the New Berne and Beaufort Canal, as well as through Clubfoot River and Harlowe Creek, so far as to secure a channel of 5 feet depth at mean low water and 30 feet bottom width from the mouth of Harlowe Creek to the mouth of Clubfoot River, thus completing a 5-foot navigation from New Berne to Beaufort, at a total expense of $72,000, in addition to the funds available June 30, 1887, this amount to be appropriated in one sum. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant, will increase the cost of the work by from $1,500 to $4,000 per appropriation.

A personal inspection of this route (made as soon as practicable after assuming charge in 1884) revealed the worthiness of this improvement. If well opened, this line would be of much value as a connecting link between Pamlico Sound and Beaufort Harbor, and would complete an otherwise already existing inland navigation from the Chesapeake to Beaufort, N. C. The dangers of ocean travel around Cape Hatteras and Cape Lookout are so great that some such 5-foot navigation for small vessels appears necessary between Pamlico Sound and Beaufort Harbor, and no similar navigation can be secured by any other route except at greatly increased expense. Further improvement over this route so as to secure a channel of more than 5 feet depth at low water is not recommended for the present.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Forty thousand dollars to secure a channel of 30 feet bottom width and 5 feet depth through the canal by dredging, and to purchase the franchise of the New Berne and Beaufort Canal Company, thus repaying it for its past expenses of dredging in the canal.

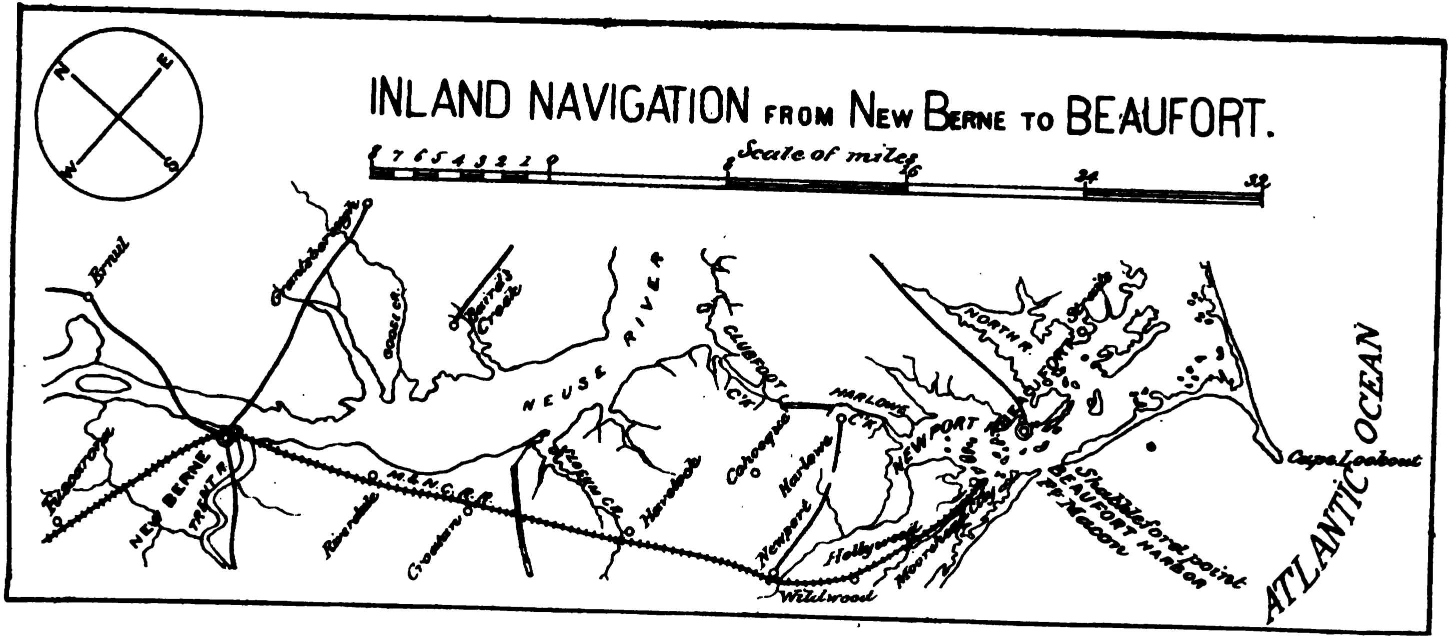
Seventeen thousand dollars to secure a channel 30 feet bottom width and 5 feet deep at low water from the head of Harlowe Creek 3.25 miles downward, to a 5-foot depth at low water in Newport River, by dredging.

Fifteen thousand dollars to secure a similar channel from the head of Clubfoot Creek to the Neuse River, by dredging.

This work is in the collection districts of Pamlico and Beaufort, N. C.

Money statement.

July 1, 1886, amount available		$7,794.24
Amount appropriated by act approved August 5, 1886		10,000.00
		17,794.24
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,257.99	
July 1, 1887, outstanding liabilities	35.50	
		1,293.49
July 1, 1887, amount available		16,500.75



INLAND NAVIGATION FROM NEW BERNE TO BEAUFORT.

the previous appropriation, allows $15,000 to be expended in dredging Harlowe River, in accordance with the approved project of securing a channel of 30 feet bottom width and 5 feet depth at low water. The contract for the dredging was awarded to Rittenhouse Moore in December, 1886, but through various delays he did not commence operations until June 21, 1887, using then shovels and wheelbarrows until his plant should be ready. By the 30th of the month he had made but little progress, the dredge not yet being on the ground. The work will, however, be pushed forward rapidly during the present season. Surveys were confined to restaking the cut to be dredged, the expenditure being $260.85.

This route affords a short and safe trip to all vessels able to use it between Neuse River and Beaufort Harbor, Core and Bogue Sounds and White Oak River, and their tributaries, and will eventually with New River. No regular commercial statistics are available, but as nearly as can be ascertained the following is a fair approximate estimate of its commerce during the past year:

Six vessels, draught (loaded) 3½ feet, making regular bi-weekly trips, annual tonnage	8,100
Fourteen vessels belonging to Core Sound oyster fleet, making three or four trips each during season, annual tonnage	800
One hundred miscellaneous craft, not registered, engaged in wood and other traffic, making altogether, say, 600 trips, annual tonnage	1,200
Total annual tonnage	10,100

There is also a small steam-boat plying between Bell's Mill and New Berne, but it passes over only a portion of Clubfoot River. Freight carried consists largely of wood, lumber, oysters, and general merchandise, New Berne being the general supply station for the coast country. Loaded vessels drawing 3½ feet can now only pass through Harlowe River at high tide. With the completion of the improvements a marked increase in the amount of commerce is to be expected, many vessels now making the long and tedious trip to Neuse River via Core and Pamlico Sounds that can not use the route in its present condition.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1883 there was no navigation by this route, and consequently no commerce.

At present about $180,000 of goods are carried through this water-way in sail-boats.

The improvement already effected (partly by private and partly by public funds) has already reduced rates of transportation between New Berne and Beaufort by about 25 per cent.

This water-way is much needed as a connecting link between Pamlico Sound and Beaufort Harbor. Besides giving the Tar, Pamlico, Trent, Contentnea, and Neuse rivers an almost direct outlet to the ocean, this water-way completes a line of inland navigation from the Chesapeake to Bogue Sound. The dangers of ocean travel around Cape Hatteras and Cape Lookout are so great that some such at least 5-foot navigation appears necessary between Pamlico Sound and Beaufort, and no similar navigation can be secured by any other route except at greatly increased expense.

No details of commerce could be procured. Those for the year ending December 30, 1886, are estimated as follows:

Cotton, rice, corn, lumber, naval stores, fish, clams, oysters, wood, and general merchandise, $150,000 to $200,000.

About 1,200 sail-boats, each of 1 to 3½ feet draught (measuring in all about 10,000 tons), passed through the canal during the year.

M 6.

IMPROVEMENT OF BEAUFORT HARBOR, NORTH CAROLINA.

(For special history of past work, see page 989, Annual Report of 1886.)

Beaufort Harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of any importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles. It is especially valuable as the natural outlet to the inland commerce of northern and middle North Carolina and as a natural harbor of refuge to vessels overtaken on this most exposed portion of the Atlantic coast.

If its channel were marked by range-lights it would be the easiest harbor to enter between the Chesapeake and Savannah. Beaufort Harbor, when placed under governmental improvement, in 1880, possessed a bar entrance of 15.3 feet least depth at mean low water, with an average rise and fall of tide of 3 feet. At this time, however, the harbor entrance was rapidly deteriorating, its width, measured from Fort Macon Point to Shackelford Point, having increased 500 feet between the years 1864 and 1880, and increased 900 feet more between the years 1880 and 1881, and its bar having rapidly and proportionally shoaled. From the bar the harbor possessed a channel of 25 feet depth upwards 3.7 miles to the Atlantic and North Carolina Railroad Wharf at Morehead City, and a branch channel of 9 feet depth for 0.6 mile up to Bulkhead Channel, and of 2 feet minimum depth 0.6 mile further to the wharves of Beaufort City, where coasting vessels had a good wharfage of 7 feet depth and 1,800 feet length.

The original project of 1881 proposed for $82,000 to stop the erosion at Shackelford Point by three 200-foot jetties to (cost $30 per linear foot), and to extend the 9-foot depth of water from Bulkhead Channel to Beaufort City, by a cutting 200 feet wide, and thence to dredge a 6-foot channel 100 feet wide to North River and Core Sound for the accommodation of the small craft of the neighboring sound. The violence of the sea's action proved so great that the 600 feet of jetty actually cost fully $36,000 ($60 per linear foot), and is not even yet sufficiently strong. Moreover, 400 feet more of jetty became necessary, and similar work became necessary on the other side of the entrance, at Fort Macon Point, so that the original estimates of 1881 have since had to be largely increased. A personal examination of the locality and work (made by me as soon as possible after assuming charge in 1884) revealed the need of such work and its importance. The projects of 1881, 1882, and 1884, as continued to date, proposed to secure this harbor by stopping further erosion of the sand-banks at Shackelford Point and Fort Macon Point, and thus stopping further deterioration of the bar entrance, and proposed to open a 5-foot channel 100 feet wide to Beaufort City. Besides the first insufficient estimates, I find that inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons the estimates for the final cost of this improvement were raised in 1885 to $159,000, and now (1887) to $163,000. The aggregated amount appropriated for these projects up to June 30, 1887, is $90,000.

Eighty-three thousand and eighty-six dollars and nineteen cents have been spent in all upon this improvement up to June 30, 1887, in successfully stopping the erosion of Shackleford Point and Fort Macon Point, in probably arresting the shoaling upon this bar, and in making a careful survey of the present condition of the harbor entrance preparatory to the definite location of further works. No improvement of commerce nor depth of water was thereby expected or obtained, but the retrograde movement has been in general arrested, the old shore-lines have commenced to reform as desired, and the former good condition of the harbor entrance is being rapidly re-established. The commerce is now about $1,000,000 exported or imported. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The special work of the year was as follows: Expenditures, $8,086.19; value of United States plant, $2,461. No work was done from September, 1885, to October, 1886, for want of funds.

The stone to be used was required to be bought by contract; but owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, all other work was allowably done by hired labor and the purchase of materials in open market.

After new appropriations were voted for this work, two new scows for receiving and handling stone were built for Government use, and the delivery of the stone was contracted for January 21, 1887, to be delivered as needed. All work has been delayed by inclement weather, difficulty of obtaining supplies and transportation, and other things consequent on the inadequacy of the appropriation.

At the main jetty, in October, small stone was replaced under 180 linear feet of undermined coping, and in May and June 392 tons of large stone (weighing about 1,000 pounds per piece) was placed along 160 feet length of its sea-front. The rest of the jetty will be similarly protected as soon as possible.

The middle jetty, built to 100 feet length in 1882, at a point 1,000 feet east of the main jetty, has almost disappeared by being gradually washed away by the North River and Core Sound currents. It needs to be reconstructed more permanently, but the present funds can not be spared therefor.

The east jetty, built to 400 feet length in 1885, at a point 2,300 feet east of the main jetty, was raised by the addition of 49 cubic yards of stone (3,298 in all since commencement). It has, as desired, effectually checked further erosion of the north side of Shackleford Point, and has commenced the restoration of the eroded point. It needs to be raised to above low-water level throughout its length.

As a result of these jetties, Shackleford Point during the past two years has, as desired, advanced towards its former shore-lines, reclaiming from the ocean a strip of beach 200 feet wide and over 1,000 feet of length.

In the course of this work the small landing wharf, the field quarters, the tram-road trestles, and a derrick had to be repaired and partly rebuilt.

At Fort Macon Point.—The small landing wharf was partially rebuilt.

The northwest jetty, 202 feet long, built opposite the old railroad wharf to protect the northern shore of Fort Macon Point from erosion by the Newport River current, was raised by the addition of 901 tons of stone. It needs to be raised above low-water level throughout its length. Though unfinished, its good effect is already perceptible. About 46 tons of stone and 45 cords of brush were built into a 340-foot length of surface revetment along the beach on both sides of the shore-end of this jetty to prevent the further flank encroachment of Newport River.

Minor surveys were made of past work and the shore-lines at both Shackleford and Fort Macon Points as a check upon the effect of past work and to obtain data for the proper prosecution and record of future work.

A tide-gauge record was kept during the progress of the work.

A careful inspection of property was made at the end of the year.

The above work has been vigorously carried forward under the immediate supervision of Assistant Engineers R. Ransom and E. D. Thompson, whose reports are herewith appended.

Recommendations for future work are as follows: That the present approved projects be completed so far as to thoroughly protect Shackleford and Fort Macon from further erosion ($69,000), and to dredge a reduced channel of 100 feet width and 5 feet depth at low water from Bulkhead Channel entirely through to Beaufort city ($4,000), at a total expense of $73,000, in addition to the funds available on June 30, 1887, this amount to be appropriated in one sum during the next year.

Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, deterioration of unfinished work, extra superintendents, and deterioration of plant, will increase the cost of the work by from $3,000 to $5,000 per appropriation.

Further improvement in accord with the original project, so as to secure to Beaufort city a channel of over 5 feet depth at low water from Bulkhead Channel, or of any depth of water by any other route to North River and Core Sound, is not recommended. This improvement once thoroughly completed should be permanent. The harbor entrance should be provided with a pair of range lights visible to a distance of 6 miles. It would then be of great value as a harbor of refuge. The least depth of water in its bar could probably be easily increased to 18 feet at low water, as it is said to have been in 1737 and 1830; $300,000 would probably cover the entire cost of this increase of depth.

This improvement, as regards cost and order of work, should be carried on, approximately, as follows:

Two thousand dollars to thoroughly riprap with heavy stone (1,000-pound pieces) the sea-front of the main jetty at Shackleford Point.

Seven thousand dollars to raise to high-tide level the railroad-wharf jetty at Fort Macon Point.

Four thousand dollars to secure a channel 100 feet wide and 5 feet deep, at low water, from Bulkhead Channel through to Beaufort city by dredging.

Two thousand dollars to re-establish line of sand-dunes along the new shore-line by means of catch-sand fences at Fort Macon Point and Shackleford Point.

Two thousand dollars to raise to high-tide level the eastern jetty at Shackleford Point.

Eight thousand dollars to reconstruct with heavy stone the middle jetty at Shackleford Point.

Eight thousand dollars to crown with concrete capping the southern jetties at Fort Macon.

Forty thousand dollars to construct 900 linear feet more of jetties at Shackleford Point at points south of the main jetty.

Beaufort is a port of entry.

Money statement.

Amount appropriated by act approved August 5, 1886		$15,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,784.77	
July 1, 1887, outstanding liabilities	1,301.42	
		8,086.19
July 1, 1887, amount available		6,913.81
Amount (estimated) required for completion of existing project		73,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		73,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing 2,000 tons of stone for improving harbor at Beaufort, N. C., opened at 12 m., January 8, 1887.

No.	Names and addresses of bidders.	Price per ton.	Remarks.
1	William M. Field, Kentmere, Del	$3.90	
2	Wm. F. Haigh, New York, N. Y	3.49	
3	Henry P. Gilbert, Georgetown, S. C	4.75	
4	Francis H. Smith, New York, N. Y	4.44	
5	David V. Howell, New York, N. Y	3.09	Except not delivered on Government wharf.
6	P. Linehan & Co., Raleigh, N. C	2.95	

Contract with P. Linehan & Co.

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., July 18, 1887.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Beaufort Harbor, North Carolina, for the fiscal year ending June 30, 1887.

The total expenses for the year are $6,997.49, divided as follows:

Pay-rolls:	
Labor and local superintendence upon scows	$633.33
Labor and local superintendence, Shackleford Point	819.04
Labor and local superintendence, Fort Macon Point	741.14
Labor and local superintendence, boats and houses, etc	67.08
Labor and local superintendence, office (charman)	7.00
General superintendence	540.44
Material:	
Upon scows	699.09
Upon wharf and tramway, Shackleford Point	200.50
Upon boats and houses (repairs)	22.12
On hand	193.38
Travel	83.75
Office rent	20.00
Stone (contract)	2,970.62

	Tons.
Stone distribution:	
Upon railroad jetty at Fort Macon Point	631.93
Upon railroad revetment, Fort Macon Point	45.46
Upon Core Sound jetty	49.26
Upon main jetty, Shackleford Point	392.23

Nothing was done until October, when preparations were begun for receiving stone which was to be brought and placed in various positions. The wharf and tramway at Shackleford Point had to be replaced, which was done during October and November. Work ceased during December owing to inability to secure lumber with which to build scows, those on hand having the year before been condemned. In January and February two scows were built, of which you have drawings and statement of entire cost in detail. In January you made a contract with P. Lineham & Co. for the supply of 2,000 tons of stone. Above I have given a statement of what has been received and how it has been applied. The delivery has been very slow, but I believe by no fault of the contractor, the railroads not furnishing a sufficiency of cars.

The work upon railroad jetty, Fort Macon Point, has brought the top of that structure throughout its length to within less than 3 feet of the surface at low water, but only a sharp ridge. To complete the jetty to mean low-water line so as to be substantial will require from 1,000 to 1,500 tons, and to carry it to high water 200 to 400 tons more of stone. A brush and stone revetment has been run both ways at the head of the jetty to prevent erosion and give greater strength, and very soon a strong log fence running east and west and deflecting to the bar will be put up as a sand-catch, thereby adding additional strength at its head. The erosion which threatened injury has ceased on the east side since the general level was raised and the revetment was run to the old railroad embankment. However, below the wharf erosion is making encroachment upon the sand-dunes. This will probably cease when the railroad jetty is carried to a higher level, as the current now shows marked deflection from the shore by its present condition, and the best results may be expected by a speedy completion of this jetty. The former work upon Macon Point remains uninjured. The sand accretions have increased to the east, south, and west, especially at the crib-works through the cuts, and in a year or so those threatening dangers will have disappeared and be even with the general banks.

The work at Shackleford has been upon the main jetty to protect it from the violence of the open sea, and a portion of its sea face has been covered with large stone of from 900 to 1,500 pounds in size, and very soon the whole face will be so protected. One concrete block has sunk about half its height; that will be soon filled even with the others. Within the year marked changes have taken place in the water-lines. Under your direction Assistant Engineer Thompson has made a map of the contours, and has sent or will send it to you. The beneficial results are apparent.

Upon Core Sound Jetty only a very little has been done, and the foregoing statement of expenses and the monthly progress maps explain fully its character. The labor upon this jetty is comprehended under the head of Shackleford Point. When finished it will, it is hoped, so far deflect the current running *out* from Core Sound and North River as greatly to aid in rebuilding the main Shackleford Point, and tend to increase the depth of the main channel to the sea.

The small jetty between the main one at Shackleford Point and that in Core Sound has nearly disappeared, and active erosion goes on at the point of its location. It is believed, however, that when the Core Sound Jetty is completed the current will be so far deflected to the northwest as to pass harmlessly by the point of present injury.

I failed to mention that 173 tons of small *crushed* stone, landed some years ago by J. A. Van Brunt, was, by your direction, used to fill in between two ridges of larger stone upon railroad jetty, Fort Macon, and it makes a capital core for such a purpose. As it was paid for direct from your office, I took no account of it in my statement of expenses.

I am expecting a report from Overseer Dill of a recent sounding ordered for the main channel over the bar and will transmit it as soon as received.

Overseer Dill has had immediate charge of the work, which he has faithfully and zealously endeavored to execute.

Future operations will progress towards the completion of the adopted project as rapidly as means are supplied by Congress, and it is needless for me to present recommendations upon a subject which has been elucidated by the reports of yourself and your predecessors.

Hereto is appended a table of commercial statistics compiled from the most reliable sources accessible to me, and which I believe to be approximately correct.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., July 14, 1887.

CAPTAIN: I have the honor to submit the following report of work done under my charge on the improvement of Beaufort Harbor, North Carolina, during the fiscal year ending June 30, 1887.

In accordance with various letters of instruction the following surveys were made: (1) A comparative survey at the crib-work west of Fort Macon, showing changes due to that work since the previous survey of May 26, 1885. Map submitted in July, 1887. (2) A hydrographical survey of Newport River, at Fort Macon Point, from stadia crosses No. 1 to 6, soundings being taken on range-lines 200 feet apart, and extending from 1,500 feet to 2,000 feet from shore. This was to determine the effect of the caving that was taking place at the time near the railroad jetty then in process of construction. Map submitted in April, 1887. (3) A shore-line survey of Fort Macon Point, showing locations of jetties, revetments, wharf, stadia crosses, and of Fort Macon and adjacent buildings, and giving the profiles of the main jetty and of section lines run from the stadia crosses to low tide, for comparison with similar surveys to be made hereafter. Map submitted in July, 1887. (4) A survey of Shackleford Point similar to the one at Fort Macon Point. This has been partially made, but other duties have so far prevented its completion. The cost of the work, field and office, was $149.12.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1881 the sand-banks which limit the width of the harbor entrance were rapidly wearing away (a sixth of a mile in one year), and the harbor-entrance bar was rapidly shoaling. The commerce is estimated to have been about the same then as now.

No marked improvement in commerce or navigation was expected. The deterioration has been stopped, and the former good condition of the harbor entrance is being re-established. The depth of water on the bar is now about 15 feet at low water. The commerce is now about $1,000,000 per year.

The rates of freight and insurance are estimated at from 33 to 50 per cent. less than in 1881.

This harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of special importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles. It is especially valuable as being the natural outlet of Albemarle and Pamlico Sound, and of the inland commerce of northern and middle North Carolina, and as being also a natural harbor of refuge for vessels overtaken on the exposed portion of the Atlantic coast, embracing Capes Hatteras and Lookout. *If its channel were properly marked by range-lights*, it would be the safest and easiest harbor to enter between the Chesapeake and Savannah. Large numbers of coasting vessels from the Tar, Pamlico, Trent, Contentnea, and Neuse rivers, and from Albemarle and Pamlico sounds, come by way of the New Berne and Beaufort Canal or Core Sound, and pass through this harbor on their way south to Wilmington, Georgetown, Charleston, and Savannah, this harbor affording them a safe and convenient exit to the ocean and permitting them to avoid the dangers of ocean navigation outside Hatteras and Lookout. The preservation and development of this harbor is of great importance to the future of the whole State of North Carolina.

The commerce of the harbor for the year ending December 30, 1886, is reported as follows:

MOVEMENT OF VESSELS.

Description.	No. of vessels.	Tonnage.
Sail vessels owned at Beaufort, N. C	97	1,718
Steam vessel owned at Beaufort, N. C	1	66
Sail vessels built at Beaufort, N. C	9	224
Vessels, increase over last year	12	248
Sail vessels arrived at Beaufort, N C	95	9,909
Steam vessels arrived at Beaufort, N. C	36	3,071
Sail vessels departed from Beaufort, N. C	87	8,696
Steam vessels departed from Beaufort, N. C	33	3,297
Vessels passed through Core Sound and Beaufort Harbor Inlet	140	5,600

NOTE.—The above table does not include the smaller vessels, of which no record is kept. The number of vessels passing through Core Sound is estimated.

COASTWISE TRAFFIC.

Imported.			Exported.		
Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
Fish .... barrels..	83,900	$70,600	Fish scraps .... tons..	1,400	$35,000
Ice .... tons..	1,250	7,500	Oil .... barrels..	1,800	12,600
Guano .... do....	700	21,000	Rice .... bushels..	5,500	3,300
Logwood .... do....	150	2,000	Cotton .... bales..	2,000	90,000
Salt .... bushels..	3,600	1,080	Oysters .... gallons..	2,500	2,000
Lumber .... feet..	480,000	4,800	Do .... bushels..	36,000	10,800
Seines .... pounds..	2,200	1,200	Clams .... barrels..	4,000	10,000
Corn .... bushels..	16,800	10,800	Fish, salt .... do....	2,600	9,800
Coal .... tons..	620	3,700	Fish, fresh .... tons..	433	34,600
All other merchandise	....	150,000	Potatoes, sweet ... bushels..	22,000	6,600
			Corn .... do....	65,000	32,500
Total imported	....	272,680	Lumber .... feet..	600,000	6,000
			Melons .... number..	68,000	6,800
Passing through the harbor:			Naval stores .... barrels..	350	1,000
General merchandise .. tons..	6,000	600,000	Peanuts .... bushels..	1,800	1,400
			Vegetables .... barrels..	2,800	8,400
			Escallops .... gallons..	300	2,400
			Total exports	....	273,700

M 7.

INLAND WATER-WAY FROM BEAUFORT HARBOR TO NEW RIVER, NORTH CAROLINA, THROUGH BOGUE SOUND.

Bogue Sound is an open water-way lying between the mainland and an outer line of sand-banks, extending from Beaufort Harbor 24 miles westward to Bogue Inlet and White Oak River, and being prolonged by narrow, crooked, tide-water creeks 17 miles further through salt-water marshes to New River, North Carolina.

The sound and marsh vary from 1 to 2 miles in width, the channels and creeks from 10 to 400 feet in width, and from 6 inches to 8 feet in depth, and the rise of tide from 0 to 5 feet according to location and prevailing winds. This water-way forms a portion of one of the proposed routes of inland navigation from the Chesapeake to Wilmington. Prior to governmental improvement in 1886, it possessed an 18 inches depth of channel at low water from Beaufort to the town of Swansborough, on White Oak River; thence a 3-foot depth at midtide 6 miles further, to Bear Inlet and Creek; thence a 6-inch depth at low water 11 miles further, to New River, whence boats of 5 feet draught could proceed 14 miles further, to the town of Jacksonville. (See report on New River, North Carolina.) Its commerce is estimated to have then been about $200,000 *per* year, carried by sail-boats of less than 2 feet draught. Personal inspection showed White Oak River basin to be agriculturally rich and apparently capable of adding $500,000 annual commerce to Bogue Sound as soon as the latter is open to 3-foot draught steamers.

The examination and survey of this water-way (reported to Congress in 1885) recommended the establishment of a channel of at least 3 feet depth at low water from Beaufort to Swansborough, and estimated its cost at $6,000. This estimate, as stated therein, was based upon a survey limited in funds and time, and made during very unfavorable weather and winds; in consequence thereof the low-water depths were greatly overestimated, and the extent of dredging correspondingly underestimated. For these reasons the estimate for the final cost of the work is now placed at $50,000. The aggregate amount appropriated for this project up to June 30, 1887, is $10,000.

Four hundred and ten dollars and fifty-seven cents has been spent in all upon this improvement up to June 30, 1887, in necessary surveys and preparation for dredging. No special improvement of commerce is to be expected until the work is complete. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The special work of the year is as follows: Expenditures, $410.57; value of United States plant, $4.80.

After appropriations were voted for this work, the dredging was contracted for (December 27, 1886), to be completed, with other contracts, before January 31, 1888. From economical considerations, this dredging will not be commenced until the fall of 1887. While awaiting the arrival of the dredge, the route of the work was carefully surveyed and preparations were made for the commencement of dredging.

Such work as was done has been vigorously carried on under the immediate supervision of Assistant Engineer E. D. Thompson, whose report is herewith appended.

Recommendations for future work are as follows: That the present approved project be completed, so far as to secure a continuous channel of 100 feet width and at least 3 feet depth at low water from Beaufort Harbor to Swansborough, White Oak River, and Bogue Inlet, at a total expense of $40,000 in addition to the funds available June 30, 1887; this amount to be appropriated in one sum. Smaller yearly appropriations will involve the disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, etc., and will increase the cost of the work by from $2,000 to $6,000 per appropriation.

Further improvement, so as to extend the navigation to New River, is not recommended at present. The improvement once thoroughly finished should remain comparatively permanent.

This improvement, as regards cost and order of work, should be carried on so as to secure first a 30-foot, then a 60-foot, and finally a 100-foot width, entirely through all the present obstructions.

This river is in the collection district of Beaufort, N. C.

Money statement.

Amount appropriated by act approved August 5, 1886		$10,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$373.07	
July 1, 1887, outstanding liabilities	37.50	
		410.57
July 1, 1887, amount available		9,589.43
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging in Bogue Sound, North Carolina, water-way between Beaufort Harbor and New River, North Carolina, opened at 12 m., November 25, 1886.

[How measured: In scows, and if deposited on banks, to be measured in situ.]

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	Chas. H. Lewis, Baltimore, Md	35	Will deduct 5 cents per cubic yard if awarded also either New River or Harlowe Creek, dredging, or both, thus making a combined bid of 30 cents per cubic yard.
2	Rittenhouse Moore, Mobile, Ala	32⅛	If awarded also New River and Harlowe Creek, dredging, 27¼ cents per cubic yard.
3	R. P. Bowdoin, Wilmington, N. C	33	

Contract with Rittenhouse Moore.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., July 13, 1887.

CAPTAIN: I have the honor to submit the following report on improving water-way between Beaufort Harbor and New River, North Carolina, for the fiscal year ending June 30, 1887.

* * * * * * *

The contract for the work was awarded December 27, 1886, to Rittenhouse Moore, of the Mobile Dredging Company. By its terms he is not required to begin work until November 1, 1887, and consequently nothing has yet been done. This date was fixed in order to allow him to finish other contracts he had entered into. During the winter, detailed surveys were made at both shoals, to determine the final location of the channel to be dredged, maps of which were forwarded to you at the time. The only expenditure was on this account, and amounted to $243.75.

COMMERCIAL STATISTICS.

The value of annual shipments from the White Oak River is estimated at $200,000. Within a few months large saw-mills have been erected at various points, and the manufacture of lumber now promises, with the opening of inland navigation, to be a leading industry. Most of the produce of the section is sent to Beaufort by small boats, but delays at Goose Creek Shoal are common, and lead not infrequently to expensive overland transportation in preference. The improvement is greatly desired by the people of the section to be benefited, Bogue Sound being the only means by which they can secure a market cheaply.

The work has been in my charge since January 1, 1887.

Very respectfully, your obedient servant,

E. D. Thompson,
Assistant Engineer.

Capt. W. H. Bixby,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1885, the commerce of this water-way is estimated to have been about $200,000 per year. The navigation was then restricted to boats of less than 2 feet draught.

No improvement is yet obtained, and none is expected until the end of the present year's work.

White Oak River, the end of the present recommended improvement, drains a rich, fertile country susceptible of considerable development. Were a 3-foot navigation possible at all tides through Bogue Sound, the present commerce may well be expected to increase to $500,000 per year. It is estimated that about $4,000,000 of lumber can readily be cut at White Oak River and sent to a profitable market at Beaufort Harbor as soon as Bogue Sound is opened to a 3-foot navigation.

The commerce for this water-way for 1886 is estimated as follows:

Articles.		Quantity.	Amount.
Cotton	bales	2,500	$100,000
Naval stores	barrels	40,000	40,000
Pea-nuts	bushels	4,000	4,000
Fish	barrels	15,000	75,000
			219,000

Besides large quantities of fresh fish, oysters, etc.

M 8.

IMPROVEMENT OF NEW RIVER, NORTH CAROLINA.

New River, emptying directly into the Atlantic Ocean between Beaufort Harbor and Wilmington, N. C., has a total length of about 52 miles, and a drainage area of 492 square miles. Its lower 14 miles, from its mouth to Jacksonville, forms a fine basin of brackish water of from 500 to 10,000 feet width and of at least 5 feet channel depth, with 20,000 acres of oyster farms, and with rich agricultural surroundings. When placed under governmental improvement in 1882, it had very poor facilities for transporting its goods to market. Its communication with the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water. Its commerce, limited to wagons and small boats, was estimated to be about $400,000 of goods per year.

The original project of 1882 proposed for $40,000 to secure a 150-foot channel 5 feet deep at low water from the upper river to the ocean, by dredging the old channel to its full size through about 7,000 feet of this oyster-rock barricade. No work was done upon this improvement up to June 30, 1885, because the available funds were regarded as too small to allow of their being spent profitably. At this time (as soon as possible after assuming charge in 1884), the location and the surroundings of the proposed work were personally inspected, and the location of the projected channel was slightly modified. This inspection showed me the agricultural richness of the river basin, its pressing need for better transportation facilities, and the worthiness of the improvement.

The present estimate (that of 1885), $40,000 for the final cost of the work, is the same as that of 1882, except that it is based upon a new location of the channel. The aggregate amount appropriated for this project up to June 30, 1887, is $20,000.

Nine thousand nine hundred and ninety-two dollars and four cents has been spent in all upon this improvement up to June 30, 1887, replacing the long and crooked channel by a short and straight channel of 40 feet bottom width and 3.5 feet depth at low water. This new channel gives great satisfaction to the neighborhood, is already in daily use by the craft entering New River from the ocean, and is steadily deepening under the scour of the river and tidal currents. The improvement is too recent to show as yet any marked increase in the commerce of the river. The latest reliable commercial statistics, those for the year ending December 30, 1886, are herewith appended.

The river navigation is not obstructed by any bridges below its present head at Jacksonville.

The special work of the year was as follows: Expenditures, $181.80. Value of United States plant, $27.30. No work could be done prior to October for want of funds.

After new appropriations were voted for this work the dredging was contracted for (December 27, 1886), to be completed with other contracts before January 31, 1888. The only work of the year has been that of minor surveys and office work. Actual dredging and work in the field will now be postponed until cold weather renders the locality safe as regards health.

The small amount of work thus done has been carried on under the immediate supervision of Assistant Engineer E. D. Thompson, whose report is herewith appended.

Recommendations for future work are as follows: That the present adopted project be completed so as to secure a channel of from 100 to 150 feet width, and 5 feet depth, at low water, from the ocean up to the upper river, at a total expense of $20,000 in addition to the funds available June 30, 1887, to be appropriated in a single amount within the next year. Smaller yearly appropriations and their consequences, the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by about $2,000 per appropriation. Further improvement, so as to give a channel of greater depth or width, is not recommended at present. This improvement, once thoroughly completed, should be permanent.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Two thousand dollars to extend the existing channel above the upper marsh upward through a few obstructing oyster-beds by dredging, and $18,000 to increase the dimensions of the above-obtained channel to 100 or 150 feet width and 5 feet depth at low tide by dredging.

This river is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1886, amount available	$189.76
Amount appropriated by act approved August 5, 1886	10,000.00
	10,189.76
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	181.80
July 1, 1887, amount available	10,007.96
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging in New River, North Carolina, opened at 12 *m., November* 25, 1886.

[How measured: If deposited on scows, scow measurement; if deposited on embankment, in situ.]

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	Charles H. Lewis, Baltimore, Md	38	Will deduct 5 cents per cubic yard if awarded also either Bogue Sound or Harlowe Creek dredging, or both, thus making a combined bid of 33 cents per cubic yard.
2	Rittenhouse Moore, Mobile, Ala	28½	If awarded, also Bogue Sound and Harlowe Creek dredging, 23¾ cents per cubic yard.
3	R. P. Bowdoin, Wilmington, N. C	29	

Contract with Rittenhouse Moore.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., July 13, 1887.

CAPTAIN: I have the honor to submit the following report on the improvement of New River, North Carolina, for the fiscal year ending June 30, 1887.

* * * * * * *

The contract for the work was awarded in December, 1886, to Rittenhouse Moore, of the Mobile Dredging Company, its performance being in abeyance to and conditional upon the completion of other dredging contracts which he undertook at the same time. On this account he has not yet begun active operations, but expects to do so during the coming fall season. No surveys have been made or expenses incurred by this office during the year.

COMMERCE.

Before the beginning of the improvement the money value of the commerce of this section was placed at $400,000, the shipments being estimated as follows:

Cotton	bales..	4,500
Rice	bushels..	35,000
Corn	do....	50,000
Pea-nuts	do....	10,000
Naval stores	barrels..	100,000
Fish	do....	50,000

And large quantities of oysters.

While the trade in naval stores has fallen off, that in agricultural products, lumber, shingles, oysters, etc., is stated to have largely increased, its total annual value now being placed between $500,000 and $600,000. With this increase is noticed at Beaufort a demand for larger vessels than were formerly used. The figures given include both water and overland transportation.

The work has been in my charge since January 1, 1887.

Very respectfully, your obedient servant,

E. D. Thompson,
Assistant Engineer.

Capt. W. H. Bixby,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work was commenced in 1882, the commerce is estimated to have been about $400,000 per year, and the navigation limited to such boats as could use a crooked channel 50 feet wide and 3 feet deep between oyster-rock shoals. No work was done prior to 1886 for want of sufficient funds.

At present there exists a good *straight* channel 40 feet wide and 3½ feet deep at low water. Although this channel was not completed until July, 1886, it is already constantly and freely used by larger boats than formerly. Nine schooners now run regularly from the head of this river to Wilmington, several to Beaufort and New Berne, and one to Philadelphia, carrying cotton, corn, pea-nuts, rice, wool, potatoes, naval stores, oysters, etc. The amount of goods carried is estimated to have already increased about 15 per cent. Insurance is seldom demanded.

New River is a fine stream, of about 14 miles length, of from 500 to 10 000 feet width, with rich agricultural surroundings and about 20,000 acres of oyster farms. Its annual commerce would probably soon be increased by $600,000 if better transportation facilities were provided.

The commerce of this river for the year ending December 30, 1886, is estimated as follows:

Articles.		Quantity.	Amount.
Cotton	bales..	4,500	$180,000
Grain (rice and corn)	bushels..	80,000	60,000
Pea-nuts	do	18 000	18 000
Naval stores	barrels..	18,000	18,000
Oysters	bushels..	20,000	60,000
Fish (salt)	barrels..	50,000	250,000
Lumber	feet..	1,000,000	10,000
Return freights	tons..	2,000	100,000
			696,000

M 9.

IMPROVEMENT OF BLACK RIVER, NORTH CAROLINA.

Black River, North Carolina, a tributary of the Cape Fear River, has (with its own main tributary) a total length of about 175 miles and a drainage area of about 1,547 square miles. This stream, prior to governmental improvement in 1886, possessed a moderately well-cleared channel from its mouth (in the Cape Fear River, 14 miles above Wilmington) 22 miles upwards to Point Caswell, with 2.5 feet depth at low water, and 4 feet depth at high tide; thence a roughly cleared navigation 48 miles further to near Lisbon, with 2.5 feet depth during nine months per year, and with 6 feet depth during six months per year. A steamer of 2.5-foot draught was regularly running once or twice per week all the year to Point Caswell, and nine months per year to Clear Run, about 10 miles below Lisbon. The commerce (including rafted goods) is estimated to have then been $750,000 per year.

The original recommendation of 1885, as continued to date, proposed for $33,500 to secure a thoroughly cleared channel of natural depth over the 70 miles of river from its mouth to near Lisbon, and afterwards a 4-foot channel at low water below Point Caswell. The aggregate amount appropriated for this project up to June 30, 1887, is $3,000; this being accompanied with a proviso that all private claims to the river navigation should be ceded to the United States before the commencement of such improvement.

Forty-two dollars and seventy cents has been spent in all upon this improvement up to June 30, 1887, in preparations for commencing work. The latest reliable commercial statistics, those for the year ending December 30, 1886, are herewith appended.

The river is obstructed by seven bridges without draws above Point Caswell. These bridges allow at present about 14 feet clear height above mean low water. These bridges will probably be provided with draws at the expense of local authorities as soon as the river navigation is much improved, so that the obstruction is not considered serious at present.

The special work of the year is as follows: Expenditures, $42.70. Value of United States plant, $4.

Owing to the variable nature of the work and the difficulty of properly specifying it beforehand and of measuring it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Certain office work and correspondence was carried on during the year with a view to the required cession of rights of way, and in June official notice was received from the State to the effect that the State acts granting such claims to private parties had been officially repealed. Work in the field will now be commenced as soon as practicable and advantageous to the Government.

Recommendations for future work are as follows: That this improvement be completed in accord with the recommendations of July, 1885, so as to secure, first, a fairly cleared natural channel over the entire river from its mouth up 70 miles to near Lisbon, then a 4-foot channel below Point Caswell, and then an improved channel through the narrows, at a total expense of $30,500 in addition to the funds available on June 30, 1887; this amount to be appropriated in yearly installments of $20,000 each until complete. Smaller yearly appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, deterioration of plant, and will increase the expense from $2,000 to $4,000 per appropriation. Further improvement so as to secure a 6-foot depth of channel below Point Caswell is not recommended at present.

After this improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Eleven thousand dollars for removing logs, stumps, snags, overhanging trees, etc., from the bed and banks of the entire river, and rounding off some of its extra sharp points at bends, giving some preference to that portion of the river between Point Caswell and the mouth of South River.

Four thousand five hundred dollars for dredging the 4-foot channel below Point Caswell.

Fifteen thousand dollars for dredging and diking in the various narrows of the upper river.

This river is in the collection district of Wilmington, N. C.

Money statement.

Amount appropriated by act approved August 5, 1886	$3,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	42.70
July 1, 1887, amount available	2,957.30
Amount (estimated) required for completion of existing project	$30,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

When work was recommended, in 1885, for this improvement the river was navigable for narrow 2.5-foot draught steamers all the year 22 miles, to Point Caswell, and nine months of the year 41 miles further, to Clear Run, within 7 miles of Lisbon, the head of the river. One steamer ran regularly over the route. The commerce is estimated to have then been about $750,000 per year.

The navigation and commerce are now about as in 1885.

This river is the main and natural outlet of Sampson County. Its improvement will place much good land in good communication with a market, and should add $500,000 to its commerce. Nothing has been done by the Government until June, 1887, because private claims to the exclusive navigation of the river had not been ceded to the United States as required by a proviso in the recommendations and appropriations.

The commerce for this river for the year ending December 30, 1886, is estimated as follows:

Articles.	Quantity.	Amount.
Cotton .... bales..	1,000	$50,000
Rosin and tar .... barrels..	100,000	100,000
Spirits turpentine .... do....	25,000	400,000
Timber and lumber .... feet..	1,500,000	150,000
Produce	....	20,000
Return freights, general merchandise .... tons..	6,000	300,000
		1,020,000

M 10.

IMPROVEMENT OF THE CAPE FEAR RIVER, ABOVE, AT, AND BELOW WILMINGTON, NORTH CAROLINA.

ABOVE WILMINGTON.

The Cape Fear River, above Wilmington, has a total length of about 400 miles and a drainage area of 7,167 square miles, of which 5,620 square miles lie above the mouth of the Black River, its main tributary. At Fayetteville, 112 miles above Wilmington, and the present head of navigation, the river varies from 112 feet breadth, 16 inches average depth, 150 square feet cross-section, 1 mile per hour current, and 200 cubic feet discharge per second in extreme droughts, up to 1,400 feet breadth, 50 feet maximum depth, 7 miles per hour velocity, and 350,000 cubic feet discharge per second in high freshets. Extreme low water usually lasts from two to four months per year, and 15-foot stages of water at Fayetteville are usually reached once a month during the rest of the year. This river, when placed under governmental improvement, in 1881, was navigable during the nine flush-water months of the year from Wilmington, 112 miles, upward to Fayetteville; but the channel for the upper 75 miles was badly obstructed by sunken logs, snags, overhanging trees, and shoals; and for the upper 66 miles it was full of shoals on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned by private parties. Its commerce is estimated to have been about $800,000 of goods transported per year.

The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river for $10,000; then to clear out its natural obstructions for $43,125 (including superintendence); and to further provide a continuous channel over its upper 66 miles by $6,900 of dredging, and by artificially contracting its water-way by jetties through at least thirty-two shoals (at a cost unstated in 1881, but estimated by the same person in 1872 at $522,720), making practically a total of at least $582,745 for the final cost of this improvement. During the year 1885 the progress of the work was examined, compared with the original estimates, and new estimates made. It was found that the natural obstructions were very numerous and difficult of removal, and the cost of their removal will exceed the original estimates. In the last five years 3,419 snags, 2,005 stumps, 2,327 logs, 2,205 trees have been removed from the river-bed, and 8,687 overhanging trees cut from its banks; but as many more remain to be removed. The violence of the freshets has proved too much for brush, log, or ordinary plank jetties, and in my opinion low stone jetties will prove the most economical in the end. The new estimates of 1885 placed the final cost of the work at $480,200.

There appears every probability that this expenditure will finally give 3 feet actual channel depth (30 inches free draught) over the whole river up to Fayetteville for eleven or twelve months per year, and that the commerce will be increased by that time to $4,000,000 of goods per year. The aggregate amount appropriated for this work up to June 30, 1887, is $76,250.

Sixty-five thousand eight hundred and thirty-two dollars and ninety-four cents has been spent in all upon this improvement up to June 30, 1887, giving a moderately well-cleared channel over the whole length of river, a moderately good continuous 4-foot channel during the entire year from Wilmington 44 miles to Kelly's Cove, thence a similar 2-foot channel 26 miles further, to Elizabethtown (a place of considerable commerce), and thence a similar 1-foot channel 42 miles further, to Fayetteville, increased to 5-foot draught from Wilmington to Fayetteville during seven months of the year. In consequence, three permanently established steam-boat lines have been running over the entire distance with full draught for seven months each year, and with lessened draught the rest of the time. The commerce during those years has increased about $200,000 per year, has been further benefited from exemption from tolls, and is now over $2,000,000 of transported goods per year, showing that each dollar spent on this improvement has been accompanied by the development of about $18 of annual commerce. The latest reliable estimates, those for the year ending December 30, 1886, are herewith appended.

The navigation of this stream is not obstructed by bridges between Wilmington and Fayetteville.

The special work of the past fiscal year was as follows: Expenditures, $1,302.13; value of United States plant, $4,790.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

No work could be done from November, 1885, to October, 1886, for want of funds, and work in the field was prevented after October, 1886, by a too high stage of water. While awating the commencing of field-work the plant was cared for and partially repaired.

The Government steam-launch has done all the towing and other service of the working parties upon the river for the last three years, and, in my opinion, has well repaid all she has cost, including her repairs. She is the only boat that can run on this river during dead low water. For economy and effectiveness during the next season's work she was this year provided with a new and larger boiler and twice as powerful machinery.

The small amount of work thus done has been carried on under the immediate supervision of Assistant Engineer Charles Humphreys.

The effect of the 2,553 linear feet of jetties so far constructed has been to better the channel and the river at and near Fayetteville and at the other worst places, and to add one month to the duration of low-water navigation, now averaging nine and five-tenths months per year.

Recommendations for future work are as follows:

Were the commerce of the river sufficiently large to justify the expenditure of such an amount, in my opinion the proper method of improving this river would be by the construction of suitable dams and locks of 32 feet total lift, giving a 6-foot navigation at all times of the year to Fayetteville, at a total cost of, approximately, $1,200,000. A commerce sufficient to justify such an expenditure cannot be expected from this locality for many years. In consequence the lock-and-dam navigation must be postponed for the present and a contracted river channel accepted as the best under the circumstances. It is recommended, therefore, that this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 4-foot channel from Wilmington, 70 miles, to Elizabethtown; thence a similar 3-foot channel 42 miles further to Fayetteville, during eleven or twelve months of the year, at a total expense of $103,950 in addition to the funds available June 30, 1887; this amount to be appropriated in yearly installments of about $120,000 until complete. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence, will increase the cost of the work from $1,000 to $4,000 per appropriation.

Further improvement, so as to extend the navigation above Fayetteville, or so as to increase its depth below Fayetteville, is not recommended.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Six-sevenths of each appropriation to increase the draught at the shoalest and most troublesome points of the river by contracting the river channel by jetties at these points, to be located in accordance with a predetermined systematic project for the entire river.

One-seventh of each appropriation to remove the most troublesome logs and snags in the river channel and to cut down and pull back the most troublesome leaning trees on the river banks.

This river is in the collection district of Wilmington, N. C.

AT AND BELOW WILMINGTON.

(For special history of past work, see page 1004, Annual Report for 1886.)

The Cape Fear River, emptying into the Atlantic Ocean at Cape Fear, has, from its mouth up to its headwaters in the mountains, a total length of about 426 miles and a drainage area of 9,115 square miles. The two main branches of this river meet at Wilmington, bringing with them an average fresh-water discharge of 14,000 cubic feet per second. Below Wilmington the river is a tidal basin, with about 26 miles length, 350 square miles drainage area, 37 square miles water surface, 3.5 feet rise of tide (2.5 at Wilmington, 4.5 at the ocean), and an average discharge during ebb of 160,000 cubic feet per second, the ocean bar being 2 miles seaward of the river mouth. The Cape Fear River below Wilmington, when placed under governmental improvement in 1829, had three bar entrances, with least depths as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel, these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta, 20 miles up to Wilmington, there were several shoals with a least depth of 7.5 feet at low water.

The original projects of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel; $203,204.59 were spent during this time in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrances.

At or about this time the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties, under an appropriation for the preservation of fortifications.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point, and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet; $156,296 26 was spent during this time upon these works, never fully completed for want of funds. The great storm of 1857 almost completely destroyed the Zeke's Island work, and the storms of 1871 cut through behind the Baldhead Jetty (now termed the Woodbury Jetty), leaving it about 1,000 feet out at sea.

The project of 1870 proposed for $257,000 a crib-closure of the space 4,403 feet long) between Smith's and Zeke's Island (finished in 1873) to prevent further widening of New Inlet. The projects of 1870 to 1872 proposed for about $300,000 the complete closure of New Inlet begun in 1875 and finished in 1881), in order to deepen the water at the main (Baldhead) bar entrance.

The projects of 1872 to 1883, as continued to date, proposed for $160,000 the extension of the New Inlet Dam 2 miles further down the stream, to prevent the further erosion of Smith's Island at the swashes. The project of 1875, as continued to date, proposed for $36,000 the occasional use of dredging upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances;

$12,000 to obtain a 12-foot depth at low water, and $24,000 more to obtain a 14 foot depth. The projects of 1874 to 1881 for the 20 miles above New Inlet, as continued to date, proposed $960,000 to be used in dredging and occasional diking wherever necessary across shoals, so as to secure for $247,000 a 12-foot channel 200 feet wide, and afterward, for $713,000 more, a 16-foot channel 270 feet wide at low water, over this whole length. The aggregate amount of the original estimates for the existing projects of 1870 to date is about $1,713,000. Unexpected engineering difficulties (such as presented by the excessive settling of foundations at New Inlet Dam, the necessity of raising this dam above high-water level, and the discovery of a forest of submerged stumps in the way of the desired dredged channels in the river-bed near Wilmington, etc., the necessity of a training-wall at Snow's Marsh Channel) and inadequate yearly appropriations and their consequences (loss from damage to unfinished work; care of property, extra superintendence, and deterioration of plant while awaiting funds, extra surveys, etc.), all these have added considerably to the cost of the work. For all these reasons, the estimates for the final cost of the work were raised in 1886 to $2,110,000, and now (1887) to $2,125,000. The aggregate amount appropriated for the existing projects of 1870 to 1882, up to June 30, 1887, is $1,860,000.

One million seven hundred and seventy-three thousand nine hundred and forty-six dollars and twenty-five cents have been spent in all up to June 30, 1887, upon the proposed improvements of 1870 to 1882, with great success, obtaining a 13.5 to 14 feet least depth of water at the main bar entrance, and completing a channel of 16 feet depth and at least 111 feet width, 28 miles further, to Wilmington. This depth, combined with the average rise of tide of 4.5 feet at the bar and 2.5 at Wilmington, is such that, at present, vessels loaded to 16 feet draught can readily go from Wilmington to the ocean in a single tide any day of the year.

The total commerce, exports and imports, foreign and coastwise, has increased from about $13,400,000 of transported goods in 1870 up to about $15,000,000 in 1886, and its foreign exports alone, from $1,500,000 in 1871 to about $6,000,000 in 1886, showing that each dollar spent on this improvement has already been accompanied by the development of about $2.40 of annual foreign commerce, although the last increase of 2 feet in draught in the river-channel is too recent to have produced its natural effect on such development.

The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The navigation of this river below Wilmington is not obstructed by bridges of any sort.

The special work of the past fiscal year was as follows: Expenditures, $76,254.51; value of United States plant, $23,840. One United States steam-tug, one United States steam suction-dredge, and fourteen scows have been in use during a portion of the year. All work of dredging and diking was suspended from February, 1886, to October, 1886, for want of funds.

After new appropriations became available, contracts were made as follows: With William A. Martin, November 30, 1886, for stone, to be completed October 30, 1887; with Fowler & Morrison, January 18, for coal, to be completed December 1, 1887; with W. M. Hawkins, January 18, for wood, to be completed December 1, 1887; with Mr. Rittenhouse Moore, January 19, 1887, for dredging, to be completed October 1, 1887; and with Atlas Dredging Company, January 19, 1887, for dredging, to be completed October 1, 1887.

Other work (including the placing of stone) for economy and advantage to the United States was allowably done by hired labor and purchase of materials in open market.

At the Shoals.—From February to June, 1887, under the above contracts, the work of dredging was carried on at the Wilmington, Brunswick River, Big Island, and Lilliput Shoals, and Snow's Marsh Channel. Three hundred and thirty-two thousand one hundred and twelve cubic yards of sand and mud, 146 large stumps, and 5 logs were removed from the river-bed so as to complete a channel through all of these shoals and marsh about 6 miles long, at least 16 feet deep at low water, except at Snow's Marsh, 111 feet wide everywhere. By December, 1887, this channel will be of full depth everywhere, and will have been widened to 185 feet everywhere and 220 feet at the bends. The several reaches of this channel are all marked by means of high guide piles driven in the river and large range-targets erected on the neighboring shore.

At the Dike.—From December to June 11,630 tons of stone were received at Wilmington, towed to place by the United States tug, and placed in position upon the dike extending southward from Zeke's Island, thus raising the dike everywhere to ordinary high-water level and making it of nearly uniform strength throughout.

The dike still needs more stone, and needs to have its top courses carefully arranged as a smooth facing.

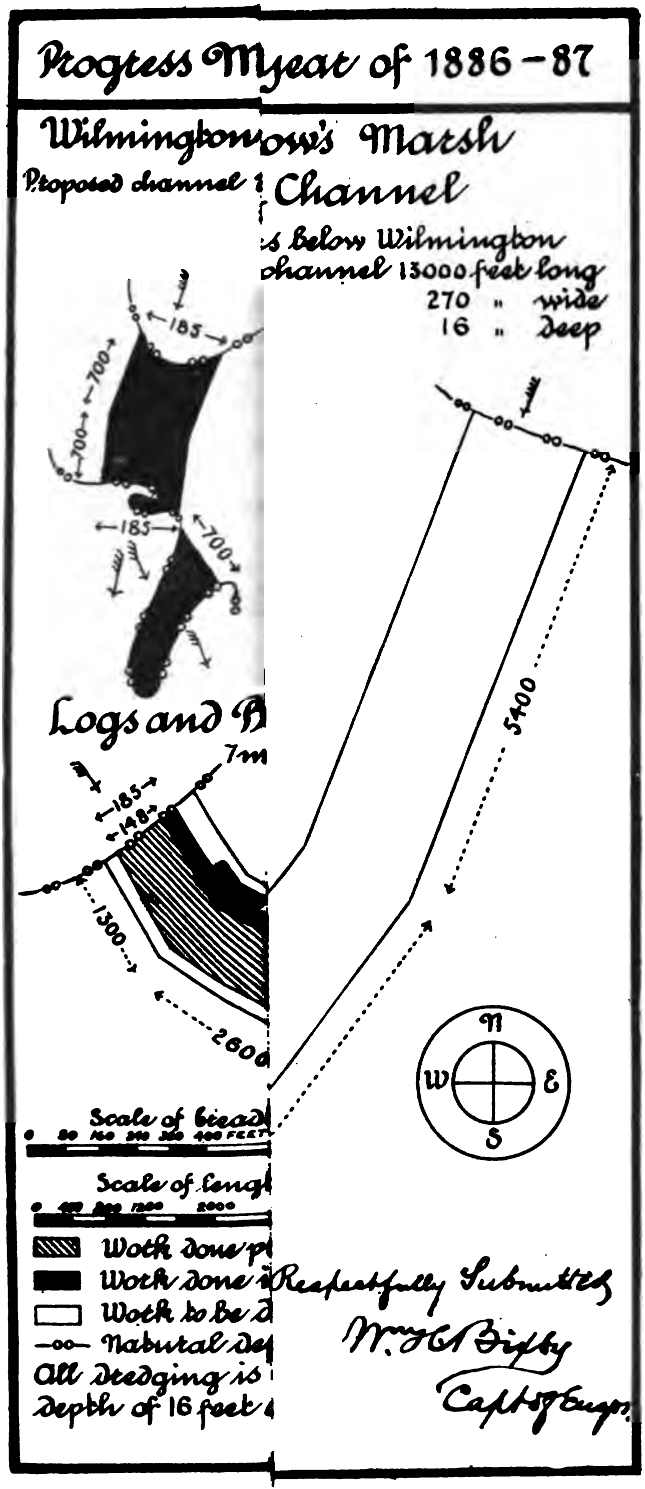
On the Bar.—Between March and June, and by the United States steamer and suction-dredge, 10,125 cubic yards of sand were removed from the newly-projected bar entrance of Baldhead Channel, at an expense of about 12 cents per cubic yard actually lifted into the sand-bins of the dredge. The action of the dredge is, however, to stir up and expose to the action of the ebb and flood currents a large amount of sand which is not lifted into her bins. At certain times when rough water prevented her from working at the bar, the dredge was kept at at work in the lower portion of Snow's Marsh Channel, where her time and labor could be utilized, the amount of work there done having been included in the amounts already reported as dredged at the shoals.

In the River.—From December to June minor surveys were made of various parts of the river to determine the condition of its shoals, at each of the various places where channels have been dredged, and at the bar entrances.

At all places, except Snow's Marsh, these surveys show so slight a shoaling in the various dredged channels as to indicate that the river currents will be able of themselves to maintain the present channels at the depths as now dredged.

At Snow's Marsh the survey shows a tendency of the river and ocean currents to cut across and through the shoal between the Snow's Marsh Channel and the old Horseshoe Channel.

At the main (Baldhead) bar entrance, the survey shows the same decided tendency of the ebb current to cut a deep channel from Baldhead Point straight to the ocean along the line of the present dredging. Here the bar has already deepened to 12½ feet least depth, and is now only 200 feet long between the 13-foot curves, 650 feet long at 14 feet depth, and only 1,400 feet long at 18 feet depth. The dredging now in progress may result this year in a straight 14 to 16 foot permanent channel direct to the ocean along this line. The existing old channel of 13½ to 14 feet least depth at mean low water is at the same time in as good condition as last year, as it now has as much as 350 feet width, and makes but two courses from Baldhead Point to the sea.


Progress Map of 1886-87
Wilmington
Proposed channel 1
ow's Marsh
Channel
s below Wilmington
channel 13000 feet long
270 " wide
16 " deep
185
700
700
700
185
700
Logs and B
7m
185
148
1300
2600
5400
N
W
E
S
Scale of bread
0 80 160 240 320 400 FEET
Scale of leng
0 400 800 1200 2000
▨ Work done p
■ Work done i
☐ Work to be d
-oo- Natural de
All dredging is
depth of 16 feet
Respectfully Submitted
Wm H Bixby
Capt of Engrs.

Money statement.

CAPE FEAR RIVER, NORTH CAROLINA, ABOVE WILMINGTON.

July 1, 1886, amount available		$469.19
Amount appropriated by act approved August 5, 1886		11,250.00
		11,719.19
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,204.39	
July 1, 1887, outstanding liabilities	97.74	
		1,302.13
July 1, 1887, amount available		10,417.06
Amount (estimated) required for completion of existing project		403,950.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		120,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

CAPE FEAR RIVER, NORTH CAROLINA, BELOW WILMINGTON.

July 1, 1886, amount available		$4,808.26
Amount appropriated by act approved August 5, 1886		157,500.00
		162,308.26
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$60,161.23	
July 1, 1887, outstanding liabilities	16,093.28	
		76,254.51
July 1, 1887, amount available		86,053.75
Amount (estimated) required for completion of existing project		265,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		265,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing a steam boiler for improving Cape Fear River, North Carolina, from Wilmington to Fayetteville, opened at 12 m., June 30, 1886.

Name and address of bidder.	Price delivered in Wilmington, N. C.	Remarks.
H. A. Ramsay & Son, Baltimore, Md.	$600	A boiler to evaporate 100 gallons of water per hour into dry steam.
	1,250	A boiler to evaporate 240 gallons of water per hour into dry steam.
	2,400	A boiler to evaporate 400 gallons of water per hour into dry steam.

Rejected; price too high.

Abstract of proposals for dredging in Cape Fear River, North Carolina, opened November 9, 1886.

[Scow measurement.]

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	Ross & Sanford, Jersey City, N. J.	15.2	Statement as to manner of me filed after opening of second
2	Frank C. Somers, Philadelphia, Pa.	15.9	Begin work Dec. 25, 1886, and by Sept. 30, 1887.
3	W. H. W. Morris, New York, N. Y.	14.9	Begin work in thirty days ar two or more dredges of 1, yards capacity per day.
4	American Dredging Company, Philadelphia, Pa.	15½	Begin Feb. 25, 1887, and finish (
5	George C. Fobes & Co., Baltimore, Md.	16½	Begin Jan. 1, 1887, and finish O
6	Rittenhouse Moore, Mobile, Ala.	15½	Begin work on notice of a contract and finish Oct. 1, 18
7	National Dredging Company, Wilmington, Del.	15½	Begin work within sixty days plete same according to spec
8	Baltimore Dredging Company, Baltimore, Md.	16	Begin work Feb. 1, 1887, and fi 1887.
9	Morris & Cumings Dredging Company, New York, N. Y.	15¾	Statement as to manner of me filed as bid was reached.

Rejected; price too high.

Abstract of proposals for furnishing 20,000 *tons of stone for improving Cape Fe North Carolina, opened* 12 *m., November* 9, 1886.

No.	Names and addresses of bidders.	Price per ton.	Remarks.
1	W. H. Trump, Philadelphia, Pa.	$2.23	Delivered at upper end of Smit bor.
2	William F. Haigh, New York, N. Y.	2.16½	Delivered at upper end of Smit bor.
3	B. G. Bailey, New York, N. Y.	1.94	Delivered at Wilmington, N. C. 15 miles thereof.
4	George Z. French, Rocky Point, N. C.	1.80 1.62	Delivered at Zeke's Island. Delivered at Wilmington.
5	William A. Martin, Wilmington, N. C.	1.52½	Delivered within the corporat Wilmington, N. C.

Contract with William A. Martin.

Abstract of proposals for dredging in Cape Fear River, North Carolina, opened 4, 1887.

[How measured: In scows.]

No.	Names and addresses of bidders.	Price per cubic yard.	No.	Names and addresses of bidders.
		Cents.		
1	P. Sanford Ross, Jersey City, N. J.	11.9	5	Rittenhouse Moore, Mobile, Ala
2	George C. Fobes & Co., Baltimore, Md.	14	6	National Dredging Company, Wilmington, Del.
3	Morris & Cumings Dredging Company, New York, N. Y.	13	7	Atlas Dredging Company, Wilmington, Del.
4	American Dredging Company, Philadelphia, Pa.	10½		

Contract with Atlas Dredging Company for one-half and Rittenhouse Moo other half.

Abstract of proposals for furnishing coal and wood for improving Cape Fear River, North Carolina, opened at 12 m. January 8, 1887.

No.	Names and addresses of bidders.	Price.	Remarks.
1	W. M. Hankins, Wilmington, N. C.	No bid for coal; $3 per cord for wood.	
2	Fowler & Morrison, Wilmington, N. C.	$4.38 per ton for coal. $3.75 per ton for coal. $3.20 per cord for wood.	Under paragraph 2 of specifications. Under paragraph 7 of specifications. Under paragraph 4 of specifications.

Contract with W. M. Hankins for wood.
Contract with Fowler & Morrison for coal.

REPORT OF MR. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., July 15, 1887.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Cape Fear River, North Carolina, from the ocean to Wilmington, during the year ending June 30, 1887.

Active operations had been suspended for the want of available funds for seven months previous to the appropriation by Congress, August 5, 1886, of $157,500.

The required and necessary formalities as to projects and advertising and letting the work by contract and giving contractors proper time for preparation consumed more than five months more; thus the active work of the fiscal year has been done during the last six months, and mostly during five months.

The operations have consisted chiefly of dredging by contract, and the delivery of stone by contract on Government scows at Wilmington; towing the same to the new dam by Government steamers and placing it on the work by hired labor, and the repairs and operation of the suction dredge.

The work done has been in continuation of the projects of 1872 to 1883, which includes the construction of the long dam or training-wall extending more than 2 miles from Zeke's Island to the marsh, as a defense against the swashes across Smith's Island, and dredging wherever needed to give 270 feet width and 16 feet depth at mean low water from the deep water of the harbor of Smithville (now Southport) to Wilmington, and whatever diking may be necessary to secure the maintenance of the channel, and the dredging at the entrance on the Baldhead Channel.

To this has been added, by Congressional sanction, the deepening of the channel at or in front of Wilmington.

Proposals for stone and dredging were advertised for and opened November 9, 1886. The contract for stone was awarded to Mr. William A. Martin, at $1.52½ per ton of 2240 pounds. The lowest bid for dredging was 14.9 cents per cubic yard. The price was too high, and there were strong indications of a combination among contractors to put up the price, and all the bids were therefore rejected.

The dredging was again advertised, and bids opened January 4, 1887, and the lowest bid was 9 cents per yard, and two bidders at that price, and neither willing to give way. The work was divided by mutual agreement between these two lowest bidders, viz: The Atlas Dredging Company and Mr. Rittenhouse Moore, and work was begun by the latter February 5, and the former March 2, 1887.

The following are the amounts of work done each month:

Month.	Cubic yards of dredging.			Atlas Dredging Company.		
	R. Moore.	Atlas Dredging Company.	Total.	Cypress stumps.	Other stumps.	Logs.
February	33,201		33,201			
March	51,056	23,010	74,066	22	6	2
April	27,819	23,419	51,238	23	2	
May	41,717	42,933	84,650	54	2	3
June	33,250	45,448	78,698	37		
Total	187,043	134,810	321,853	136	10	5

The large stumps and logs were to be paid for at contract rates by the term contract; large cypress or elm stumps at $40 each; other stumps at $10, at $20.

Mr. Moore's work has been on the lower reach of the Lilliput Shoal the Br Shoal, and the work at Wilmington.

The work of the Atlas Company is on the Log's and Big Island Shoal an upper reach of the Lilliput Shoal.

So far all the stumps and logs have been taken from the Log's and Big Isla by the Atlas Company. They have all been removed by digging around t hoisting them with the ordinary clam-shell bucket. In no instance has d been used.

The state of the different channels at the end of the year is as follows: A of 185 feet width has been dredged across the shoal in front of Wilmington detached shoal just below the channel has been removed, all to the depth o at mean low water. Two additional cuts of 37 feet each have been mad lower half of the Brunswick River Shoal, making the width there 185 feet. Th on the upper half is begun, and both will be finished during July, making t throughout the shoal 185 feet, and depth 16 feet at low water, increasing from 111 feet. At the Log's and Big Island Shoal one additional cut has b throughout, making the width 185 feet, and at the upper angle an addition been made of 400 feet length, giving a width of 222 feet.

At the Lilliput Shoal two additional cuts have been completed on the lo making the whole width 185 feet.

On the upper reach one additional cut is completed, giving a width of 14 a further widening to 185 feet is in progress for a distance of 1,600 feet angle.

The following are the amounts of work done on each of the four shoals present project:

Name of shoal.	Dredging under contract in progress.	Dredgin under former co tract.
Wilmington	73,748	......
Brunswick River	34,798	99,26
Logs and Big Island	106,742	198,12
Lilliput	106,565	238,27
Totals	321,853	535,6

The total numbers of large stumps and logs removed in both contracts lows: The large stumps and logs removed on former contract, at $40 eac and 10, respectively, of which 75 were from the Brunswick Shoal, 312 fro and Big Island Shoal, and 2 from Lilliput Shoal, making the total numb stumps 525, and logs 15.

The lengths of the several channels which have been dredged under t project of 1881 for making 16 feet depth at mean low water and 270 feet the deep water at Southport (Smithville) Harbor to Wilmington are as fo

Name of channel or shoal.	Length of channel in feet.	Name of channel or shoal.
Snow's Marsh Channel	12,800	Brunswick River Shoal
Midnight Shoal	7,400	Wilmington Shoal
Lilliput Shoal	11,000	
Logs and Big Island Shoal	8,500	Total

Nearly 9 miles.

The two former were finished to the width and depth in 1883.

The amount of dredging done on all the shoals since the commence present project, in 1881, is 2,199,197 cubic yards.

Dredging to the amount of 372,271 cubic yards was done on the Snow's nel from September, 1874, to May, 1876, first to make a channel 9 feet feet deep at low water and 200 feet in width, thus making the tot dredging 2,571,468 cubic yards.

No very material deterioration has occurred in the dredged channels, excepting in the Snow's Marsh Channel. This was observed from the first on a considerable portion of the upper reach (above the marsh), where the tidal currents cross it, both at ebb and flood, at a slight angle; the material on both sides being a very soft mud, mixed with some sand. Shoaling has also occurred at another point, directly opposite the main opening between the Marsh Islands, known as the thoroughfare, through which the tidal basin in the rear of the marsh is to a considerable extent filled and emptied. Here the shoaling is mostly sand, which is probably carried along by the tidal current and deposited at this place by the sudden slacking of the current, caused by the flow through the thoroughfare, which towards the last of the main flood is ebb, and the last of the main ebb is flood.

The remedy for this would be the stopping of the thoroughfare, which would require about 3,000 tons of stone riprap.

The shoaling of Snow's Marsh Channel was repaired to some extent, from October 24 to December 30, 1885, by dredging two deep cuts through the central portion to a depth of 18 feet and a width of 74 feet over a distance of about 6,400 feet. The amount of material removed was 111,709 cubic yards, and fully that amount of dredging will be required to restore the channel to as good a condition as at the completion of the repairs.

There are two remedies for this deterioration; and one of them, the construction of a training-wall on the easterly side of the upper reach, extending from the high shoal opposite the upper end of the marsh to deep water above, a distance of about 6,300 feet, and the closure of the thoroughfare has been recommended in previous reports. A second remedy is now suggested, that of abandoning the upper reach of the channel, and allowing the currents to take their present natural course through the Five Fathom Hole, and connecting the pocket below with the lower end of the Snow's Marsh Channel.

A careful survey of the whole locality has lately been made and the map is presented herewith, showing the location of the proposed channel. The length of the route now proposed is not more than 700 feet greater than that of the present dredged channel in a total length of 4 miles, and its courses quite as favorable for navigation.

A comparison with previous surveys shows that nature is taking the initiative in making this channel. Two passages across the Horseshoe Shoal (referred to in the last report) are in the general direction of the proposed channel, and during the last year they have widened and their tendency is to come nearer into the proposed channel.

From an inspection of the map of the whole locality from Reeve's Point to the deep water below Price's Creek, it appears evident that the natural courses of the tidal currents are coincident with the proposed route.

To make 16 feet at low water, dredging will only be required on about 7,500 feet length (as shown on the map). Its estimated cost for a width of 270 feet is about the same as that of the training-wall, so that a final decision as to choice between a training-wall or a newly-dredged channel may best be left until the funds for the work are voted and available for use.

Considering the contingencies connected with the construction of the training-wall, such as undermining and flanking, etc., the proposition for dredging the connecting channel is to-day less bold than the construction of the wall.

Before the passages above referred to were scoured across the wide shoals the proposition of dredging would have appeared too bold. The position of the long new dam is in harmony with the proposed channel, and it has probably had some influence in this scouring across the shoals.

The estimate for the wall is retained, with decision reserved as to whether the funds shall finally be used for a wall or for a dredged channel.

The delivery of stone for the continuation of the construction of the dam before referred to was begun at the last of December, 1886. The following are the amounts delivered each month by Mr. Martin:

[Ton of stone=2,240 pounds.]

Month received.	No. of tons.	Month received.	No. of tons.
December, 1886	163.07	May, 1887	1,391.43
January, 1887	1,525.57	June, 1887	1,585.82
February, 1887	2,502.71		
March, 1887	1,895.21	Total	10,717.97
April, 1887	1,654.16		

In addition to this, 912.08 tons of stone ballast have been purchased during the fiscal year, at from 75 cents to $1.15 per ton, the whole cost being $782.98, an average of 86 cents per ton, making a total tonnage of 11,630.05.

The stone has been distributed over nearly the whole length of the work, and for a small portion of its length sufficient stone is placed for finishing by facing the slopes and top with the larger sizes of the stone. A beginning has been made of this, making the top of the dam 6 feet in width, with slopes of 1 on 1½. The level of the top is the same as that of the new inlet dam, or about that of ordinary high spring tides.

The finishing is not begun until the dam has had for some time the full weight of the finished work.

The plant, consisting mostly of the suction dredge steamer *Woodbury*, the steam-tug *James T. Easton*, fourteen stone scows, and the scows with the steam hoister and pile-driver, suffered severely from being laid up for more than a year.

Extensive repairs have been necessary. Estimated for the *Woodbury*, $4,000; for the scows, $2,000. No extraordinary repairs were required for the *Easton*, as she was kept in use occasionally. The *Woodbury* had been laid up most of the time since October, 1881.

The cost of the repairs of the *Woodbury* has been $3,661.10, and that of the sixteen scows $1,519.63.

Extensive repairs were required at the Island wharf, near the new dam, which was built for the quarters of the men and depot of materials for the dam. It has been thoroughly repaired by driving more than 100 new piles, and moving a portion of the superstructure to the new piles, at a cost of $540.81.

The repairs of the *Woodbury* were finished February 18, and she was put to towing the stone for the dam in place of the *Easton*, which required some repairs.

The *Woodbury* begun her regular work at the Baldhead Channel, March 25. When wind and weather prevented work on the bar, she was operating on the shoal at the lower reach of the Snow's Marsh Channel.

She remained at the regular work until April 26, when she again took the place of the tug *Easton*, while she was laid up to have her broken main shaft replaced by a new one, and for repairs of damages occasioned by the breaking of the shaft.

On May 23 the *Woodbury* was again at her regular work. She has proved to be quite as efficient as ever before as a suction dredge.

The capacity of the sand bins is 50 yards. The usual load is about 45 cubic yards The usual time of dredging a load is from 20 to 30 minutes, and about as much time i spent in going back and forth and dumping in deep water.

The amount of dredging done in each month is as follows:

Month.	Baldhead Channel.	Snow's Marsh Channel.	Total.
	Cub. yds.	*Cub. yds.*	*Cub. yds.*
March 25-31	1,201.6	669.3	1,870.
April 1-26	4,802.5	1,938.6	6,741.
May 23-31	661.5	2,435.3	3,096.
June 1-30	3,459.4	5,215.6	8,675
Total	10,125	10,258.8	20,383.

This makes an average of about 8,500 cubic yards per month. The cost of opera tions, including repairs, fuel, and an allowance for deterioration, is estimated a $1,000 per month; this makes the cost of dredging about 11¾ cents per cubic yar The largest amounts of work done on single days are 587 and 588 cubic yards.

The effect of the dredging is perceptible in both places. The dredging at Baldhea Bar has been on the line of the channel from Baldhead Point directly towards th bar through the deep pocket. When operations were begun in March the lea depths on the proposed channel were 12 feet at low water, and the distance betwe the 13-foot curves was fully 550 feet. The least depth has been increased to 12¼ fee and the distance between the 13-foot curve has been decreased to 200 feet, while t distance between the 14-foot curves remains about the same (650 feet). The 14-fo curve has advanced seaward about 200 feet.

The Baldhead Channel is in a better condition than ever before, so far as history goe There has been a general deepening over the whole area in the vicinity of the cha nel. There is now a least depth of 14 feet at mean low water and a least width 350 feet. It can be run in two courses from the sea to the deep water inside of Bal head Point, and there is good reason to expect that a straight course may be ma available by the work of the *Woodbury* and the greater help of natural forces.

The shoal around which the turn has been made for many years in the channel has been constantly moving seaward in the direction of the straight channel. It has moved about 200 feet during the past year and 2,600 feet since 1877 (from our own surveys), and 3,800 feet since 1872 from comparison with the Coast Survey.

It is plain that this shoal and its movement seaward is acting efficiently as a submerged jetty, and the prospect is good for its further extension. This, with the comparatively little assistance of the suction-dredge, will probably cause a straight and deep channel to be made over the bar.

The shoal is so wide and extensive that there is hardly a possibility of its being flanked. The shoal on the other, or westerly, side of the channel also acts as a submerged jetty, but this has always been flanked by the Oak Island, or Western, and Rip Channel. When the Baldhead Channel shall have taken its permanent shape, there can be but little doubt of the advantage of closing (to some extent at least) the Rip Channel, and of securing ultimately at least 20 feet depth at mean low water over the Baldhead Channel and the bar.

The effect of the dredging by the *Woodbury* at the Snow's Marsh Channel is still more obvious. The work was begun there over a shoal of hard sand, 1,200 feet in length, with a least depth of from 12 to 13 feet. Now there is a least depth of from 14 to 14½ feet. There has been a movement of the shoal with the ebb tide southward, into the deeper water. It is probable that the *Woodbury* can keep this shoal down to the proper depth by working on it only when the weather prevents work on the bar. The two new passages of 6 feet depth and upward, which have been scoured out across the shoals above the Horseshoe Channel, referred to above as well as in the last report, still exist, and are somewhat wider than before, and slightly deeper. They have taken a direction nearer coincident with the main channel, and have caused no deterioration in the channel. It seems obvious that these passages will not be detrimental to the main channel any more than the Horseshoe Channel, which empties almost perpendicularly into it, and has done for many years. They are really like safety-valves, in preventing flanking at the head of the shoal, near the head of the marsh. The great tidal reservoir eastward and above the Snow's Marsh Channel must be filled and emptied in a great measure from below the channel, and that is at present the use of these new channels and the Horseshoe Channel.

The New Inlet Dam remains in the same good and finished condition as at the last report.

The shore-lines of Federal Point, and its extension over the Caroline Shoals, remain nearly the same as at the last report, excepting at the extreme end of the New Beach. The distance between this and the head of Smith's Island is reduced to 650 feet at high water, where the width was 1,000 feet at the beginning of the year. There is very little depth of water at low tide on the bar in front of this inlet. This inlet has become so contracted and shallow, that the tides which formerly were usually one hour or more earlier on the sea-side of the New Inlet Dam, with consequent difference of level, are now later than the river tides on the other side, and the differences of level are diminished.

The shore-lines of Zeke's Island and the head of Smith's Island remain in substantially the same condition as at the last report. The swashes across the long, narrow beach of Smith's Island still remain open, as at the beginning of the year. Their total width at high water has slightly increased, but at low water there has been a decrease in width of more than 800 feet. Some of the shoals at the openings are nearly up to ordinary high-water level. The sea has encroached less than formerly on the beaches between the swashes, and on the whole their condition is favorable for a natural closure after the completion of the new dam. Their total widths at high and low water are 4,350 feet and 1,975 feet, against 4,050 and 2,780 feet at the beginning of the year.

No great change has occurred in the shore-line of Baldhead Point and Oak Island, on the opposite side of the entrance.

There is a tendency to accretion on the sea-side of Baldhead Point rather than erosion, which has heretofore occurred steadily for many years. During the past year accretion has occurred of about 100 feet in width and 800 feet in length. The shore now stands about 500 feet further inland than in 1877 for a distance of about one-third of a mile from the point. Further southward *accretion* has occurred, so that the line of the beach is 1,000 feet further *seaward* than in 1877. The tendency now seems to be for this shoal to advance northward, and finally hook around the former site of the point, and perhaps reform it at the former location at the old stone jetty.

During the year hydrographic surveys have been made of the Baldhead Channel and vicinity and one of the Horseshoe and the Snow's Marsh Channel and vicinity, and also surveys of the shore-line of Federal Point, Zeke's and Smith's islands, and the beaches at and between the swashes.

The series of projects now in the way of completion began with the appropriation of 1870.

The following is the list of appropriations by Congress:

Date.	Amount.	Date.	Amount.
July 11, 1870	$100,000	March 3, 1879	$100,000
March, 8, 1871	75,000	June 14, 1880	70,000
June 10, 1872	100,000	March 3, 1881	140,000
March 3, 1873	100,000	August 2, 1882	225,000
June 23, 1874	150,000	July 4, 1884	200,000
March 3, 1875	150,000	August 5, 1886	157,500
August 14, 1876	132,500		
June 18, 1878	160,000	Total	1,860,000

The present project embraces the completion of the dredged channels across all the shoals where dredging is required to make 270 feet width and 16 feet depth at mean low water; the completion of the long dam from Zeke's Island to the Big Marsh; the construction of the jetty or training-wall at the head of Snow's Marsh for the preservation of the dredged channel or dredging for the same; the repairs of the dredged channels by dredging where there has been deterioration; and the operation of the suction-dredge *Woodbury* on the Baldhead Channel.

The following is the estimate of the amounts required for the completion of the project, including the amount of appropriation available July 1, 1887.

After deducting from the estimate of dredging in the last report the amount done since, it will be seen that the present estimate is nearly 200,000 yards in excess. This is on account of the necessary dredging to repair the Snow's Marsh Channel. The excess of stone is occasioned by some actual and expected subsidence and an unexpected quantity to be used in making the compact facings:

170,000 cubic yards of dredging under present contract, at 9 cents	$15,300.00
600,000 cubic yards of dredging, at 12½ cents	75,000.00
500 large stumps and logs to be removed, at $40	20,000.0
9,282 tons of stone for dam per contract, at $1.52½	14,155.0
5,000 tons of stone for dam per contract, at $1.75	8,750.0
Cost of towage from Wilmington, 14,282 tons, at 35 cents	4,998.7
Cost of placing the stone on dam, 14,282 tons, at 40 cents	5,712.8
Facing the top and slopes with the stone, 10,000 feet, at $1	10,000.0
41,680 tons stone delivered for jetty at Snow's Marsh, at $2	83,360.0
Cost of labor unloading stone at jetty, 15 cents per ton	6,252.0
Cost of 100 piles driven at jetty	300.0
Operation of the *Woodbury* 24 months on Baldhead Channel	24,000.0
Repairs of steamers, including new boiler for *Woodbury*	3,500.0
Add 10 per cent. for office work and superintendence	27,122.8
Add 10 per cent. for office work and contingencies	27,122.8
Total	325,574.2

I will forward a letter from Mr. C. H. Robinson, collector of customs for this port in which he states the amount of revenue collected for this year and other valuabl information.

I will also have a statement of the commercial statistics of the port prepared fro the best authorities and forwarded to you.

The work is in the collection district of Wilmington, N. C. The nearest ligh houses are at Baldhead Point and Oak Island, at the mouth of the river.

Very respectfully, your obedient servant,

HENRY BACON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Above Wilmington to Fayetteville.—When work commenced, in 1881, the river w badly obstructed and only navigable nine months of the year; and the navigati was owned by a private corporation. The commerce is estimated to have then be about $800,000 per year.

At present, the river is fairly well cleared of obstructions, is navigable all the ye for light-draught steamers, and for 5-foot draught boats during nine months of t year. Steamers now run regularly and daily. The commerce is now about $2,000, per year.

The rates of freight have been reduced about 33 per cent., and river insurance is regarded as unnecessary, except against fire.

The commerce has increased about $200,000 per year since work begun, in 1881. Every dollar spent so far upon the improvement has been accompanied by the development of about $18 of annual commerce. In addition to this, the former tolls are removed. The river steamers last year were fully loaded each trip that they were able to make; and much more so than formerly since they were tolerably certain of always reaching Fayetteville. There is every indication that a never-failing 3 foot channel to Fayetteville would increase the present commerce by $2,000,000 per year.

The present commerce of the upper river for the year ending December 30, 1886, is estimated as follows:

Articles.	Quantity.	Value.
Cotton .... bales..	11, 997	$479, 880. 00
Spirits turpentine .... casks..	19, 989	329, 818. 50
Rosin .... barrels..	68, 307	68, 307. 00
Crude turpentine .... do....	1, 113	1, 446. 90
Tar .... do....	13, 590	17, 667. 00
Timber .... feet..	8, 345. 000	83, 450. 00
Flour .... barrels..	18, 541	92, 705. 00
Grain .... bushels..	72, 712	54, 534. 00
Fertilizers .... bags..	60, 094	120, 188. 00
Miscellaneous packages (estimated) .... tons..	8, 000	800, 000. 00
Total	....	2, 047, 996. 40

At and below Wilmington.—When work commenced, in 1829, the river navigation was restricted to 7.5-foot-draught boats. The river commerce of then is unknown.

At present, the river is navigated by 16-foot-draught steamers, and its commerce is about $15,000,000 per year, although the last increase of depth of 2 feet is too recent to have yet produced any effect on the development of commerce.

The rates of freight and insurance have been greatly lowered by the improvement, but the amount of decrease is not easily stated. The foreign commerce has increased from about $1,500,000 of exports in 1871 to about $6,000,000 in 1886; a gain of about $40 in annual foreign exports for each dollar spent on the improvement in that time. The development of this port means the development of all North Carolina, and of many Western States who can reach Europe most quickly by the existing North Carolina railroads, the Cape Fear River, and the ocean.

Statistics have been sought unsuccessfully for the full commerce of the lower river. Those which have been obtained are as follows:

Foreign and domestic imports and exports and tonnage for the year ending December 31, 1886.

EXPORTS.

Articles.	Foreign.	Domestic.	Total.	Value.
Cotton .... bales..	109, 860	25, 152	134, 512	$5, 784, 016
Spirits turpentine .... barrels..	41, 738	21, 046	62, 784	1, 035, 936
Rosin .... do....	310, 444	29, 307	339, 751	339, 751
Tar .... do....	8, 588	55, 637	64, 225	83, 492
Crude turpentine .... do....	....	....	24, 409	31, 732
Pitch .... do....	....	....	4, 330	6, 711
Peanuts .... bushels..	404	79, 159	79, 563	47, 738
Lumber .... feet..	10, 133, 000	29, 379, 241	39, 512, 241	592, 684
Shingles .... number..	2, 057, 000	7, 209, 560	9, 266, 560	46, 133
Miscellaneous	....	....	....	3, 000, 000
Total	....	....	....	10, 968, 193

IMPORTS.

	Total tons.	Value.
Estimated quantity and value	80, 000	$6, 000, 000
Total exports and imports	....	16, 968, 193

Foreign and domestic imports and exports and tonnage, &c.—Continued.

TONNAGE.

Vessels.	Foreign.	Domestic.	Total.
Steam-ships	33,129	46,183	79,312
Barques	52,403	456	52,859
Brigs	7,388	1,750	9,138
Schooners	618	48,187	48,805
Total			190,114

Entrances, foreign	166
Clearances, foreign	211
Entrances, coastwise	102
Clearances, coastwise	58
Vessels documented (net tons 6,651.89)	64
Total receipts at custom-house	$21,885.19

LETTER OF THE COLLECTOR OF CUSTOMS AT WILMINGTON, NORTH CAROLINA.

CUSTOM-HOUSE, WILMINGTON, N. C.,
Collector's Office, July 16, 1887.

SIR: The transactions at this office for the year ending June 30, 1887, were as follows:

RECEIPTS.

Import duties	$19,601.2
Tonnage	3,248.4
All others	2,019.3
Total	24,869.07

EXPORTS.

Domestic products	$6,088,24
Foreign products	
Total	6,088,25

Import and warehouse entries	8
Entries, foreign	14
Clearances, foreign	20
Entries, coastwise	10
Clearances, coastwise	5
Vessels documented	5
Tons	5,287.1

Statement of vessels of over 100 *tons at the port of Wilmington for the years ending Jun* 30, 1886 *and* 1887.

	Year ending June 30, 1886.		Year ending June 30, 1887.	
	Vessels.	Tons.	Vessels.	Tons.
American	237	98,247	216	89,3
Foreign	166	73,548	161	82,1
Totals	403	171,795	377	171,4

Exports for the years ending June 30, 1886 and 1887.

Articles.	Year ending June 30, 1886.			Year ending June 30, 1887.		
	Coastwise.	Foreign.	Total.	Coastwise.	Foreign.	Total.
Cotton................bales..	27,665	73,213	101,078	23,640	109,691	133,331
Spirits turpentine...casks..	20,128	43,817	63,945	21,606	44,389	65,995
Rosin..............barrels..	40,541	288,270	328,811	23,822	302,993	326,815
Tar.................do....	53,281	9,073	62,354	57,012	10,352	67,364
Crude turpentine.....do....	18,810	....	18,810	24,202	20	24,222
Lumber...............feet..	26,117,940	9,256,087	35,373,977	29,205,891	13,038,891	42,244,782
Pitch..............barrels..	3,745	10	3,755	4,962	16	4,978
Shingles..........number..	7,410,150	1,276,660	8,686,810	4,336,903	2,102,450	6,439,353

[Furnished by Jno. L. Cantwell, secretary Chamber of Commerce, Wilmington, N. C.]

M 11.

IMPROVEMENT OF YADKIN RIVER, NORTH CAROLINA.

(For map of river and location of obstructions, see Annual Report of 1883.)

The Yadkin River, North Carolina, has a total length of about 200 miles and a drainage area of 4,320 square miles. Its middle third, extending from the railroad bridge near Salisbury 64½ miles upward to the foot of Bean Shoal, is the only portion so far under improvement by the General Government. This portion of the Yadkin River, prior to governmental improvement in 1880, had a slope of about 2 feet to the mile, and its navigation was completely obstructed by rock ledges, fish and mill dams, and numerous shoals, with a greatest depth of 1 foot at ordinary low water on some of its shoals and ledges. Its river commerce was therefore nothing. The original project of 1879 proposed, for $82,000, to secure a 2.5 to 3 foot steamboat navigation during the entire year over the 64½ miles above the Salisbury railroad bridge. This estimate must have been based mainly upon theoretical considerations, since subsequent practice showed that this sum was sufficient to give the desired depth of navigation for only two-thirds of the year and over only one-third of the distance. A personal examination of the river over the 32 miles above the Salisbury railroad bridge (made as soon as possible after assuming charge in 1886) confirmed these points, and moreover showed me the agricultural richness of the river-basin and its urgent need for transportation facilities. By careful reconsideration of the original estimates as checked by my personal examinations and recent surveys, the estimates for the final cost of the work necessary to give the desired depth over the entire 64½ miles, and during only mean winter stages of water (two-thirds of the year) are herewith raised to $400,000. The aggregate amount appropriated for this project up to June 30, 1887, is $87,000.

Seventy-seven thousand two hundred and sixty-five dollars and ninety cents has been spent, in all, upon this improvement up to June 30, 1887, in securing a good channel for flat-boats (and only an indifferent channel for steam-boats) of 40 to 70 feet width, and from 2 to 2½ feet depth during mean winter stages of water (eight months of the year) from the Salisbury railroad bridge, 21 miles upward, to above Swicegood's Mill. No river commerce has yet been created, and none is expected until the improvement reaches Bailey's Ferry, 35 miles above the Salisbury railroad bridge.

The navigation of the river within these 64 miles is not obstructed by bridges without draws.

The special work of the year is as follows: Expenditures, $8,650; value of United States plant, $5,917; two United States steam-hoisters and necessary boats were in use during a portion of the year.

Owing to its varied nature, and the difficulty of properly specifying it beforehand and measuring it up afterwards, the work was allowably carried on by hired labor and the purchase of materials in open market.

No work was done from 1885 until October, 1886, for want of adequate funds, and no work of clearing out the river was done from then till June, 1887, because of unfavorable stages of water. On 11th August, 1886, the charge of this work was transferred from Capt. F. A. Hinman to Capt. W. H. Bixby. While awaiting a favorable time for beginning active work the United States plant was put in thorough repair (two new hoister-scows, two quarters boats, one office boat, one commissary boat, and five stone-scows being built, and one new hoisting-engine purchased and mounted ready for work), and surveys were made of the remaining nine ledges or dams which are yet to be improved before any development of the river commerce can be expected.

During June work was commenced at the lowest ledges, Nos. 17 and 18, and at Peebles Dam (24 to 26 miles above the Salisbury railroad bridge), and 15 trees and 4 cords of brush were trimmed from the neighboring bank, 227 cubic yards of rock, 92 cubic yards of sand and pebbles were removed from the river-bed, and this rock with 14 cords of brush were built into 358 feet length of wing-dams, leaving a clear channel of at least 60 feet width and 3 feet depth at mean winter water at these points.

A water-gauge record was kept at Hairston's Ferry during the year.

A careful inspection of property was made at the end of the year.

All the above work has been well and vigorously carried forward under the immediate supervision of Overseer and Acting Superintendent Frank Brown and Assistant Engineer E. D. Thompson, whose reports are herewith appended.

Recommendations for future work are as follows: That this improvement be completed in accordance with the existing projects only so far as to secure a cleared channel-way of 60 feet clear width and 2.5 to 3 feet clear depth at average winter water (eight months of the year) from the railroad landing close to and just below the Salisbury railroad bridge, 35 miles up to Bailey's Ferry, at an expense of $20,000 in addition to the funds on hand on June 30, 1887, this amount to be appropriated at once in a single sum. Smaller appropriations will involve alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence and care of property, and will increase the cost from $2,000 to $6,000 per year. Further improvement so as to extend this navigation over the remaining 30 miles is not recommended until the development of a reasonable commerce on the lower 35 miles shall show the worthiness of further improvement.

This recommended improvement, once thoroughly finished, should be comparatively permanent.

This improvement, as regards cost and order of work, shall be carried on approximately, as follows:

Twenty thousand dollars to secure a channel-way of 60 feet clear width and 2 feet clear depth at average winter water from the landing

just below Salisbury railroad bridge, 35 miles upward to Bailey's Ferry, by blasting, dredging, jettying, diking, snagging, and bank-trimming, deepening this later to from 2.5 to 3 feet.

This river is in the fifth collection district of North Carolina.

Money statement.

July 1, 1886, amount available		$8,384.10
Amount appropriated by act approved August 5, 1886		10,000.00
		18,384.10
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,338.83	
July 1, 1887, outstanding liabilities	1,311.17	
		8,650.00
July 1, 1887, amount available		9,734.10
Amount (estimated) required for completion of existing project		313,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1887.

CAPTAIN: I have the honor to submit the following final report on the examinations and surveys of Yadkin River, North Carolina, during May and June, 1887.

The examination extended from the completed improvement at Swicegood's Mill to Bailey's Ferry, about 12 miles. It included detailed surveys at the following localities, maps and reports of which have been already submitted, viz: Oakes Ferry Shoal, Ledges Nos. 17 and 18, Peeble's Mill Dam, ledge 1,500 feet above Peeble's Mill, Ledge No. 19, ledge 1,000 feet below Hartley's Mill, Hartley's Mill Dam, Ledges Nos. 20 and 21 and Grime's Mill Dam. At other places where shoals exist soundings were taken without instrumental location to determine whether a channel of the required width and depth adopted for this river already existed. Between Grime's Mill and Bailey's Ferry there are five such places. With Hairston Ferry gauge reading 3 feet these showed a channel depth of not less than 3.8 feet. Mr. Crotz, the present owner of Grime's Mill, has materials on hand for raising the crest of his dam 1 foot, and expects to do the work during the coming low-water season. The effect of this will be to increase the depths of water on these shoals to a considerable extent, the current now being slack in the pool above the dam.

The surveys were made as follows: A line of stakes 50 feet apart were put in on either bank at each locality. At each stake a range was established and marked on the opposite side of the river by another stake, the distances between being measured by stadia. Between these stakes a line tagged every 10 feet was stretched until the tags indicated the measured distances, a method which avoids all errors due to the unknown amount of elasticity in the line. Soundings were taken at the tags, levels of the bottom being also taken when the number of the party admitted it. Otherwise, as each range was sounded, its water-surfaces at each extremity were measured and referred to a local bench-mark. Slope was also taken. These surveys had for their object the determination of the most economical and advantageous channel of a clear width of 60 feet and 3 feet depth at mean low-water stage. The original assumption upon which all the works of improvement on this river are based is "that when Hairston Ferry gauge reads 2 feet above the dead low water of 1881, then the river for many miles above and below is at its mean low stage." (Report of Chief of Engineers for 1882, p. 1104.) As nearly as could be determined this stage reads 2.6 feet on the present gauge. Soundings were therefore referred to this gauge. This method does not give entirely correct results, when the survey at any locality was made when the water was considerably above mean stage, the error being the difference in the slopes of the two stages. At the same time it was the only practicable way in which to do the work in the absence of reliable data regarding slopes and the heights of local mean low water. During the progress of surveys local gauges were maintained to guard against errors due to sudden changes in the river.

Following are the estimates of cost for the proposed channel at the localities surveyed:

Locality.	Miles.*	Amount.
Oaks Ferry Shoal	23	$3,441.30
Ledge No. 17	24	240.00
Ledge No. 18	25	1,606.60
Peeble's Mill Dam	26	8,431.87
Ledge 1,500 feet above Peeble's Mill Dam	27	10.00
Ledge No. 19	27	602.25
Hartley's Mill Dam	28	5,291.77
Ledges Nos. 20 and 21	30	256.20
Grime's Mill Dam	31	3,604.81
Total	....	23,484.80

*Above railroad bridge.

Or, in round numbers, $25,000 will be required to complete the improvement as proposed from Swicegood's Mill to Bailey's Ferry. This amount does not include the payment of damages to any mill-owner, the channel at the dams being so located and designed as to rather improve than injure the water-powers passed.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. FRANK BROWN, OVERSEER.

UNITED STATES ENGINEER OFFICE,
Fork Church, N. C., June 30, 1887.

CAPTAIN: I have the honor to make the following annual report of work done on the Yadkin River, North Carolina, during the year ending June 30, 1887:

For unknown reasons to me I received no instructions to work during the summer of 1886. The Yadkin was then in charge of Capt. F. A. Hinman, Corps of Engineers, whose headquarters are at Norfolk, Va. On July 30, 1886, the Yadkin was transferred to your district. Under date of October 25 instructions were received from you, viz, "To build where necessary, and repair old flats until I had in good condition and ready for work two hoister scows, two quarter-boats, eight stone flats, one office flat, and one commissary boat."

As soon thereafter as estimates and specifications could be made out and approved sealed proposals for 50,000 feet of lumber (or as much more as would be needed) were issued. The following are parties to whom proposals were issued, also price shown:

	Per M.
Davis Brothers, Fork Church, Davie County, N. C	$20.00
Alfred Wood & Son, Tyro, Davidson County, N. C	19.00
J. H. Young, Tyro, Davidson County, N. C	18.50

Acceptance was at once issued to J. H. Young.

In January carpenters and help carpenters were hired and work begun on new plant. Sheets marked A show boats built, material used, and total cost of each boat. A Lidgerwood double-drum engine was bought and placed upon one new hoister scow; on the other, one of the old single-drum hoisting engines. In order to put the last in good working order, some parts of the old one had to be used, consequently it is left in a dismantled condition, and as a hoisting engine is useless. I therefore respectfully recommend that it be sold.

On June 2, the plant was removed from Hairston's Ferry, up the river to Ledge No. 18. At this point four bank protectors and two training-walls were built with the stone excavated from proposed channel. Two hundred and seventy-eight linear feet of dams have been built at this ledge, containing 103 yards of stone and 3 cords of brush. At Ledge No. 17, 80 linear feet of dams have been built, containing 84 yards of stone; this stone was excavated from proposed channel. Inclosed you have maps showing location of protectors and dams.

Twenty-nine yards of stone were loaded on stone scows, and hauled to Peeble's Mill Dam, for use in training walls.

The following is the work for the season:

Rock excavated	cubic yards..	227
Sand and pebbles (approximate)	do....	92
Brush cut and used in dams	cords..	4
Blasts made		132
Linear feet holes drilled		300
Linear feet dams built		358
Pounds of powder used		158

The commercial statistics of that section of country lying contiguous to the Yadkin from the North Carolina Railroad to foot of Bean's Shoals for the years 1886 and 1887:

Indian corn	bushels..	500,000
Wheat	do....	160,000
Rye	do....	4,800
Oats	do....	62,000
Tobacco	pounds..	1,800,000
Cotton (exclusive of Rowan County)	bales..	2,000

Large quantities of useful hard woods abound in the valley of the Yadkin, and I have many inquiries as to the advisability of rafting lumber down the river to the railroad.

Very respectfully, your obedient servant,

FRANK BROWN.
Overseer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1880 there was no navigable channel on account of obstructing shoals, rock ledges, and mill-dams, and consequently no commerce.

At present an indifferent channel of from 40 to 70 feet width and 2¼ feet depth during the flush-water season has been secured from the North Carolina Railroad Bridge near Salisbury up 21 miles. There is no navigable channel at low water. No commerce can be expected until the improvement is extended 14 miles further. Then a small boat may be placed on 35 miles of the river.

The river flows through a fertile country mainly without railroad facilities. Were the river open to free and safe navigation all the year, a commerce of from $500,000 to $1,500,000 would soon be developed; but such an improved navigation, costing about $600,000 for construction and $25,000 per year for maintenance, is not contemplated at present. The restricted flush-water navigation sought by the present project may furnish an annual commerce of $500,000 per year in a few years after the improvement is finished.

The products of the neighborhood for the year ending December 30, 1886, are estimated roughly as follows:

Articles.		Quantity.	Amount.
Indian corn	bushels..	298,800	$261,300
Wheat	do....	81,138	
Rye	do....	5,600	
Oats	do....	50,000	
Tobacco	pounds..	800,000	64,000
Cotton	bales....	1,800	72,000
Total		....	397,300

M 12.

IMPROVEMENT OF WACCAMAW RIVER, SOUTH CAROLINA.

(For special history of past work, see page 1024, Annual Report for 1886.)

The Waccamaw River, emptying into Winyaw Bay at Georgetown, S. C., has a total length of about 214 miles and a drainage area of 1,572 square miles of rich agricultural lands. This river, prior to governmental improvement in 1880, was navigable for 12-foot draught boats at all stages of water from Georgetown, Winyaw Bay, 26 miles to Bull Creek, and at high water 6 miles further to Buck's Lower Mills; thence for 7-foot draught boats at high water 31 miles further to Conwayborough; thence it possessed an obstructed channel for 3-foot draught boats at ordinary water 109 miles to Reeve's Ferry, the present head of steam navigation; thence an obstructed channel with 3-foot depth at high water for 42 miles to Lake Waccamaw. The commerce of this river is estimated to have then been about $400,000 of transported goods per year.

The original project of 1880, as continued to date, proposed for $29,000 to secure a channel 12 feet deep at all stages of water, with 80 feet bottom width, from the mouth of the river upward to Conwayborough, and afterwards a cleared channel to Lake Waccamaw. This estimate was required to be made hastily, inexpensively, and during a high-water stage in the river. Its insufficiency became so evident that in 1883 $54,000 was recommended to do work originally estimated at $10,000, and later 1,000 logs, trees, and snags have been removed in a single year from portions of the channel bed, supposed in 1880 to have been free from such obstructions. A personal examination of the river over its entire length (made as soon as possible after assuming charge in 1884), revealed these facts, and, moreover, showed me the agricultural richness of the river basin; its urgent need of better water transportation facilities, and the worthiness of the improvement. During the fiscal year of 1885 careful surveys were made to determine the condition of all shoals where jetties had been formerly constructed or started, and also of all shoals and sharp bends where improvement appeared specially desirable. At all places where jetties had been completed they appear to have done good, as the boats experience less trouble to-day in passing these localities; but for the want of adequate funds and other reasons half of these jetties were left unfinished, and the other half were only imperfectly and hurriedly finished. The present maps are sufficient for the construction of careful projects everywhere, and the required depth is now easily obtainable if the necessary funds be appropriated therefor. Besides the first insufficient estimates, I find that inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons, the estimates for the final cost of this work were raised in 1885 to $138,400. The aggregate amount appropriated for this project up June 30, 1887, is $50,400.

Forty-five thousand one hundred and twelve dollars and eight cents have been spent in all upon this improvement up to June 30, 1887, giving a thoroughly cleared channel, with 100 feet least width and 8.8 feet leas depth at high water, as far as Conway, and with 45 feet width and feet depth for 30 miles above Conway. The commerce upon this portion of the river has been thereby increased to about $1,600,000 per year showing that each dollar spent on this improvement has been accompanied by a development of about $26 of annual commerce. The lates reliable commercial statistics, those of the year ending December 30 1886, are herewith appended.

The river above Reeve's Ferry is crossed by three county bridges without draws. When needed, the draws will undoubtedly be put in by th county authorities, so that they are not regarded as serious obstruction at present.

The special work of the year is as follows: Expenditures, $9,744.92; value of United States plant, $285; one United States hand hoister, and one hired steam hoister have been in use a portion of the year. Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market. No work was done prior to October for want of funds. Between that date and June, 1887, and from 34 miles of river (from 1 mile below to 33 miles above Conway), 3,080 logs, 500 stumps, 1,914 large snags, 191 cords small snags, 6 barrels rosin, 1 sunken flat, and 368 cubic yards of mud were removed from the river bed; and 4,220 trees (cut down), 233 trees (deaded), 1,354 trees with roots (pulled back), and 814 cords of brush (from 44,823 linear feet of bank) were removed from or prevented from further obstructing the river bank. In this way the river was thoroughly cleared for 12 miles, and roughly for 21 miles more to at least 40 feet width and 3 feet depth at low water. In June a minor survey of the river was made from Georgetown nearly to Reeve's Ferry, with a view to obtaining a map suitable for properly recording and ordering future work.

A water-gauge record was kept during the year.

A careful inspection of property was made at the end of the year.

The general charge of the work has been under the immediate superintendence of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project so far as at present to secure a channel 12 feet deep at mean low water, with 80 feet bottom width, from the mouth of the river 43 miles up to Bucksville; and thence a channel 10 feet deep at mean low water, with 80 feet bottom width 20 miles further to Conwayborough; thence a thoroughly cleared 3-foot navigation 109 miles further to Reeve's Ferry, throughout the entire year; and thence a thoroughly cleared natural channel 42 miles further, to Lake Waccamaw, at a total expense of $88,000 in addition to the funds available June 30, 1887, this amount to be appropriated in yearly installments of $70,000 until complete. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioriation of plant, will increase the cost of the work by from $1,000 to $4,000 per appropriation. Further improvement in accord with the original project, so as to secure a 12-foot navigation at all stages of water, from Bucksville 20 miles to Conwayborough, is not recommended at present.

After this improvement is finished its proper maintenance may cost from $1,000 to $4,000 per year.

This improvement, as regards order and cost of work, should be carried on approximately as follows:

Thirty thousand dollars to secure a cleared natural channel for steam navigation from Conwayborough, 109 miles, upward to Reeve's Ferry, by removing sunken logs and snags, and by cutting down and pulling back from caving banks the trees that would otherwise soon fall into the river.

Eighteen thousand dollars to secure a 12-foot navigation at high water from the mouth of the river upward to Bucksville, and a similar 10-foot navigation thence upward to Conwayborough, by dredging and jettying.

Forty thousand dollars to secure a deepened navigation at all stages of tide and water of 12 feet depth from the mouth to Bucksville; 10 feet depth thence to Conway, and 3 feet depth to Reeve's Ferry, and to give a cleared and natural channel thence to Lake Waccemaw.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1886, amount available		$32.84
Amount appropriated by act approved August 5, 1886		15,000.00
		15,032.84
July 1, 1887, amount expended during fiscal year, exclusive of libilities outstanding July 1, 1886	$8,729.32	
July 1, 1887, outstanding liabilities	1,015.60	
		9,744.92
July 1, 1887, amount available		5,287.92
Amount (estimated) reqired for completion of existing project		88,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		70,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., July 7, 1887.

CAPTAIN: I have the honor to make the following report upon the improvement of the Waccemaw River, South Carolina, for fiscal year ending June 30, 1887.

By agreement, Mr. Thomas W. Daggett furnished a thoroughly equipped self-propelling steam hoister, and with it work commenced at Little Needle Eye Cut-off, about 1 mile below Conway, on October 13, 1886. Operations continued here eight days, the cut having been deepened to 4 feet at low-water, with 50 feet width. In accomplishing this there were removed 9 stumps, 1 log, 28 cords roots, and 368 cubic yards of mud. The cut-off avoids a very sharp bend in the river, filled with sunken timber. Its present condition allows its use by passing steamers at ordinary stages of low water. Before its final completion some more excavation will be needed, though not much.

On the 21st of October, 1886, operations begun above the town of Conway, under the approved project looking to a channel 3 feet deep at dead low water. During the year a hand hoister was constructed by the United States, which, being supplied with a full crew of nine men, did some excellent work along with the steam hoister in January, February, and March last. This hoister ceased work on March 31, so as to give Mr. Daggett's steam hoister the benefit of the remainder of the appropriation. His hoister was built at a considerable expense to himself, expressly for work on the Waccemaw, and inasmuch as the character of work done by him was so superior and in every way satisfactory, it was deemed but just that he should have every consideration shown him by the Government, consistent with strict economy. For these reasons the hand hoister was laid up.

To the end of the present fiscal year the improvement had reached a point about 96 miles (according to distances at present in use on the river) above Georgetown, and approximately 33 miles above Conway. Of this distance, 12 miles of the rive was quite thoroughly cleared, and 21 miles roughly.

Mr. Daggett's hoister (including the material taken from Little Needle Eye Cut-off did the following work for the year: Removed from the channel 2,857 logs, 456 stumps 1,711 large snags, 183 cords of small snags, 6 barrels rosin, 1 sunken flat, and 368 cubic yards of mud. From the banks, 1,663 trees, 99 trees "deaded," 219 cords brush and 7,405 running feet of bank cleared.

Work of the United States hand hoister: Removed from the channel 223 logs, 4 stumps, 203 large snags, 8 cords of small snags; obstructions removed from the banks 1,354 trees with roots, 2,557 trees cut and trimmed, 595 cords of brush, 134 tree "deaded," and 37,418 running feet of bank cleared.

The foregoing work greatly improved the section of the river over which it extended. The excellence of the work is highly spoken of by all who have seen it, an the captains of the steamers running on the river are loud in their praise of th benefit to navigation. The steamers can now run safely at night where it was wit difficulty that they could get along at all in daylight before the obstructions were removed. The reputation of the improvement stands well with the citizens of the Waccamaw country, and they are extremely anxious to have it extended upward as quickly as possible. There is no doubt but that the opening of the Upper Waccemaw will soon very largely increase the commerce and develop the rich resources all along the river.

Much credit is due Mr. Thomas W. Daggett for the success of this improvement. He never leaves off using every effort in the rapid prosecution of the work, and he spares no pains nor expense in providing his hoister with every convenience for most efficient work.

Dynamite has been used during the year with marked economy in removing obstructions.

An inexpensive survey was made from Georgetown to Star Bluff. From Georgetown to Oat Bed Shoal the measurements were made with a floatable rubber tape, 500 feet in length, and from Oat Bed to Star Bluff by stadia measurements. The floatable tape gave great satisfaction for rapid-river measurements. The notes were plotted in the field as fast as taken, and the maps were thus roughly completed. The map of this survey, 11 sheets, is respectfully sent herewith.

RECOMMENDATIONS.

It is respectfully recommended that work be continued above Conway as rapidly as possible, so as to get the entire length of the river open—first to uninterrupted pole-flat navigation; after this, roughly cleared for steamboat navigation; after this, thoroughly clear the channel.

It is recommended, however, that the river be cleared soon as possible for steamboat navigation to Star Bluff, and from that point for pole-flat navigation next.

It is believed that the Upper Waccemaw is, in every way, well worthy of improvement by the General Government, and that the increase in the commerce would be sooner brought about by opening the river above Conway prior to any other work on the stream, and that by so doing a greater number of people will be benefited.

COMMERCE.

I would respectfully refer you to the commercial statistics, forwarded in January last, for the calendar year 1886. No more reliable information than that can be obtained now on this subject.

It is generally admitted that there has been an increase in the shipments of naval stores from above Conway since the improvement of that section of the stream, but just exactly what that increase amounts to I have been unable to ascertain.

I am greatly indebted to Mr. A. Z. Banta, timekeeper and overseer of this work, for the faithful and most efficient performance of his duties. Mr. Banta is recommended as a correct, prompt, hard-working man wherever his services may be needed. I consider Mr. Banta the equal of any of my acquaintances in superintending and conducting river works.

Mr. H. F. Price, surveyor, did a great deal of work in a very short time, and at a comparatively small cost, in surveying the river. My thanks are also due him.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1880 the river was navigable for 12-foot draught boats up 24 miles, thence for 7-foot draught boats at high water 37 miles more to Conway. Everywhere the river was more or less obstructed. Its commerce is estimated to have then been about $400,000 per year, carried by one steamer, one steam-tug, and fifty-four schooners.

At present the low-water navigation has been carried up for 3-foot draught boats to a point 24 miles above Conway. The river has been thoroughly cleared of all dangerous obstructions to Conway and roughly cleared above. The commerce is now estimated at $1,600,000 per year, carried by three steamers, two tugs, and seventy ocean schooners.

The rates of freight have been greatly lowered and marine insurance below Conway is considered unnecessary, except against fire.

This river flows through an exceedingly fertile country, as yet without railroad or other good transportation facilities. Every dollar so far spent upon this improvement has been accompanied by the development of over $26 of annual commerce. The same rapid development should continue as further appropriations become available and are expended.

Full statistics as to the river commerce were sought unsuccessfully from the steamboat companies. The commerce for the year ending December 30, 1886, is, however, estimated as follows:

Articles.	Quantity.	Amount.
Cotton .... bales..	5,000	$200,000
Spirits turpentine .... barrels..	10,000	165,000
Rosin and tar .... do....	60,000	60,000
Rice (rough) .... bushels..	100,000	100,000
Rice (cleaned) .... barrels..	20,000	300,000
Lumber .... feet..	5,000,000	75,000
Shingles .... number..	3,000,000	15,000
General merchandise, mainly return freights .... tons..	15,000	750,000
		1,665,000

M 13.

IMPROVEMENT OF GREAT PEE DEE RIVER, SOUTH CAROLINA.

(For special history of past work, see page 1019, Annual Report of 1886.)

The Great Pee Dee River, emptying into Winyaw Bay at Georgetown, S. C., has (including its upper portion, called the Yadkin) a total length of about 500 miles and a drainage area of 16,329 square miles, of which 9,642 square miles lie above the mouths of the Black, Lynche's, and Little Pee Dee, its main tributaries. At Cheraw, at a stage of 0.5 foot above low water, its discharge is about 7,000 cubic feet per second. This river, prior to governmental improvement in 1880, was dangerously obstructed with snags and logs everywhere. Otherwise it was easily reached at a point 37 miles above its mouth by 9-foot draught boats coming by way of the Waccemaw and Bull Creek; thence it was navigable for the same boats 24 miles further, to Smith's Mills, and thence for 3.5-feet draught boats at low water 54 miles further, to Little Bluff or at high water 110 miles further, from Smith's Mills to Cheraw, the present head of steam navigation, 171 miles above Georgetown. The commerce of the river is estimated to have then been $400,000 of good transported per year.

The original project of 1880, as continued to date, proposed for $25,00 to secure a thoroughly cleared 9-foot navigation to Smith's Mills, an a 3.5-foot navigation to Cheraw at all stages of water. This estimat was based on an examination required to be made hastily and inexpe sively. As regards logs and snags, the estimate allowed for only 50 in all (two per mile, on an average); whereas, as well as can now be est mated, over 2,500 logs and snags have actually been removed, and abou 4,500 more are awaiting removal (in all, 32 per mile). Moreover, thes logs are extremely large, and their removal proportionately expensiv A personal inspection of the entire river (as soon as possible after a suming charge in 1884) revealed these facts, and, moreover, showed m the agricultural richness of the river basin, its urgent need of bett transportation facilities, and the worthiness of the improvement. B sides the first insufficient estimates, I find that inadequate yearly a propriations and their consequences (the alternate disorganization a reorganization of working parties, damage to unfinished work, ext superintendence, and deterioration of plant) have added considerably to the cost of the work. For all the above reasons the estimates for the final cost of the work were raised in 1885 to $117,000. The aggregate amount appropriated for this project up to June 30, 1887, is $47,000.

Thirty-seven thousand three hundred and fifty eight dollars and eleven cents have been expended in all upon this improvement up to June 30, 1887, giving at all ordinary stages of water a well-cleared 9-foot navigation 61 miles upward, to Smith's Mills; and a fairly cleared 3.5-foot navigation at low water 50 miles further, to the railroad station at Pee Dee, or, at high water, 110 miles further, from Smith's Mills to Cheraw. The commerce of the river has thereby been increased so as to be at present about $2,000,000 per year, showing that each dollar spent on this improvement has been accompanied by the development of about $43 of annual commerce. The latest reliable commercial statistics, those for the year ending December 30, 1886, are herewith appended.

The navigation of the river is obstructed at points, as shown by the following extract from special report dated December 18, 1886:

> About 125 miles above Georgetown this river is crossed by the Wilmington, Columbia and Augusta Railroad, on a bridge provided with a draw-span of suitable width. Projecting iron-work on the piers, swift cross-currents in the river, and an improperly arranged piling-fender combine to subject passing vessels to injury.
>
> Several miles above the railroad bridge the river is crossed by the toll-bridge of the Society Hill Bridge Company on a through bridge provided with a draw-span of proper width. Swift and cross currents and the absence of suitable fenders combine to subject passing vessels to injury by the bridge piers.
>
> I recommend that the owners of both these bridges be required to provide strong and suitable fenders at both ends of these draw openings, these fenders extending 100 feet above and below the bridge, and rising above ordinary high water to within about a foot of the draw-span's lower chord.

The special work of the year is as follows: Expenditures, $10,438.68. Value of United States plant, $1,965. One United States hoister and one hired hoister were in use during a portion of the year.

No work was done prior to October, for want of funds. Between that date and June, 1887, and from the entire length of river, 996 logs, 438 stumps, 82 trees, 44 large snags, 22 cords of small snags were removed from the river-bed; and 2,023 trees and 12 cords of brush (15,336 linear feet of cleared bank) were removed from the river-banks. A small survey was made of the river in June with a view of obtaining a map suitable for properly ordering and recording future work.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

A water-gauge record was kept during the working season.

A careful inspection of property was made at the end of the year.

The general charge of the work has been under the immediate superintendence of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 9-foot navigation to Smith's Mills, and thence a 3.5-foot navigation to Cheraw at all stages of water, at a total expense of $70,000 in addition to the funds available June 30, 1887; this amount to be appropriated in yearly installments of $60,000 until complete. Smaller appropriations will increase the cost of the work from $2,000 to $5,000 per appropriation. Further improvement, so as to extend the navigation above Cheraw, is not recommended for the present.

After the improvement is finished its proper maintenance may cost from $2,000 to $5,000 per year to properly maintain the improved channel.

This improvement, as regards cost and order of work, should be carried on approximately as follows: The entire length of river should be examined and improved uniformly each year. During the low-water stage the most troublesome sunken logs and snags should be removed from the channel. During the high-water stage the most troublesome leaning trees should be cut down and pulled back from the banks, as also such trees on caving banks as appear liable to fall into the river channel during the following year.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1886, amount available		$80.57
Amount appropriated by act approved August 5, 1886		20,000.00
		20,080.57
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$9,045.22	
July 1, 1887, outstanding liabilities	1,393.46	
		10,438.68
July 1, 1887, amount available		9,641.89
Amount (estimated) required for completion of existing project		70,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., July 8, 1887.

CAPTAIN: I have the honor to make the following report upon this river for fiscal year ending June 30, 1887:

Operations have been carried on both above and below Smith's Mills; at the forme place by Skinner & Ferris's hoister, under written agreement, work having been begun November 6, 1886; and at the lower place by the United States steam hoister work having been begun October 25, 1886.

The present approved project provides for a depth of channel of 3.5 feet at dead low water, above Smith's Mills. The hoister on that section of the river (Smith' Mills to Cheraw) had worked over the entire distance, and returned to a point withi 15 miles of Smith's Mills on June 30, 1887. In this way the channel and river bank were roughly cleared of obstructions, as follows:

From the channel, 590 logs, 351 stumps, 82 trees, 21.5 cords of snags.

From the river banks, 1,178 trees (many of them removed with roots), 11.61 cord brush, 12,026 running feet of banks cleared.

Below Smith's Mills the present approved project contemplates a depth of channel of 9 feet at dead low water. The United States hoister, to June 30, 1887, ha worked over the entire river, from Port Harrelson, where the first of the work seeme to be needed, to Smith's Mills, and returned to a point about 15 miles below. In thi way the channel and river banks were roughly cleared of obstructions, as follows:

From the channel, 406 logs, 87 stumps, 44 large snags, 10 cords small snags.

From the river banks, 845 trees, 3,310 running feet of banks cleared.

This hoister is less powerful than any other in the district, has a greater depth t clear at dead low water, and has the disadvantage of not being a self-propeller; but, o the other hand, its cost of operating is less. During the year progress of the wor was occasionally retarded by high water. A hand hoister, quarter-boat and row-boa were built, the property cared for and kept in excellent repair.

An inexpensive survey, by floatable rubber-tube measurements, is now being mad from Cheraw to Georgetown.

A boat-house was built at Georgetown and paid for in part by this work.

There is no doubt but that the past year's work greatly improved the navigation of the river.

Whenever possible information was asked from passing boats as to the location of the present most troublesome obstructions, and when given those particular obstructions were removed in preference to any others. The work has been distributed over the entire length of the river in the most judicious manner possible. It is believed that every log, snag, or stump removed from the channel, and every tree cut from the banks improved the condition of the river. Certainly there is still very much to be done of this same character of work. It is not to be expected that some 200 miles of river, possessing the natural features of the Great Pedee, could be *thoroughly cleared* of obstructions in the time the United States has been carrying on the improvement. The appropriations have been very small, not allowing the work to go on continuously. There are some shoals in the river upon which there is less depth than the projects call for, but just exactly the number and extent of them will require a detailed survey of each one to ascertain.

RECOMMENDATIONS.

It is respectfully recommended that operations be carried on as heretofore, viz: Work over the river, back and forth, removing the worst obstructions first, and in this way continue till the channel is thoroughly cleared. As far as possible, do the channel work during the low stages of the water, and cut the growth from the caving banks when the river is high.

The Great Pedee is a very important river in this State, worthy in every way of improvement by the General Government. The number of people to be benefited by affording uninterrupted navigation is very large, and the rich resources of the country to be developed by cheap and certain transportation is very great. There is an established trade on the river of no small value, and every dollar expended by the United States has increased that traffic to a certain extent. This will continue to be the case as the improvement is carried on.

COMMERCE.

You are respectfully referred to the commercial statistics furnished in January last for the calendar year of 1886. No more reliable information than that can be obtained now as regards this subject.

Mr. S. R. Rhodes, overseer, and E. C. Easterling and George D. Anderson, time-keepers, deserve much credit for the cheerful and correct performance of their duties. They have my thanks.

There is no better place than this to thank Mr. Alden James, clerk, for his intelligence and valuable assistance in every endeavor to carry out your orders relative to the works under this office.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1880 the river was navigable at low water for 8-foot draught steamers 37 miles, and at high water for 3.5-foot draught steamers 171 miles to Cheraw. The river was then dangerously obstructed, however, by snags, and accidents to the steamers were of common occurrence. The commerce is estimated to have then been about $400,000 per year.

At present boats run as before, but without danger. Three steamers and many pole-boats run to Cheraw, and 30 ocean schooners to Smith's Mills. The commerce is now estimated at about $2,000,000 per year.

The rates of insurance are now very low, since accidents rarely, if ever, happen to the steamers. The rates of freight from Cheraw have been reduced from 25 to 60 per cent. by the improvement of the river.

The country in the neighborhood of the river is steadily developing under the influence of better transportation facilities. Each dollar so far spent upon this improvement has been accompanied by the development of about $43 of annual commerce. It is estimated that prospective benefits to commerce will be in proportion to those of the past.

Efforts to obtain from the steam-boat companies full statistics of the river commerce have been unsuccessful. The commerce for the year ending December 30, 1886, is estimated as follows:

Articles.	Quantity.	Amount.
DOWNWARD.		
Cotton .... bales..	20,000	$800,000
Spirits turpentine .... barrels..	8,000	128,000
Rosin and tar .... do ..	50,000	50 000
Rice .... bushels..	100,000	100,000
Ton timber .... sticks..	8,000	40,000
Lumber (cypress) .... feet..	2,000,000	30,000
Shingles .... number..	4,000,000	20,000
UPWARD.		
Fertilisers and general merchandise .... tons..	15,000	1,000,000
		2,168,000

M 14.

IMPROVEMENT OF GEORGETOWN HARBOR, SOUTH CAROLINA.

(For special history of past work, see p. 1029 Annual Report for 1886.)

Georgetown is situated at the head of Winyaw Bay, and at the confluence of the Sampit, Black, Great Pee Dee, and Waccemaw rivers (these rivers having conjointly a drainage area of 18,040 square miles), and is the natural harbor and sea-port for all commerce passing to and from these rivers and their tributaries. Georgetown is also a railroad terminus. This harbor, prior to governmental improvement in 1880, had an excellent, well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth. A bar of about 2,850 feet length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown, 13 miles to the ocean. The commerce of this harbor is estimated to have then been about $4,000,000 of transported goods per year, carried by thirty schooners, seven steamboats, and two steam-tugs, measuring in all about 9,000 tons.

The original project of 1881, as continued to date, proposed for $14,000 to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through this bar. This estimate was based on the supposition that the bar was composed only of sand and mud. Inadequate appropriations delayed the work until 1884, and when actual work was commenced it was found that the sand and mud was a mere thin surface-covering to an old cypress swamp, involving the further removal of about 600 enormous stumps. A personal inspection of the locality and work (made as soon as possible after assuming charge in 1884) showed me the necessity of increasing former estimates, and showed also the present and future commercial importance of this harbor and the worthiness of the improvement. Besides the first insufficient estimates, I find that inadequate appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence and deterioration of plant) have added considerably to the cost of the work. For all the above reasons, the estimates for the final cost of this work were raised in 1885 to $39,000, and now (1887) to $42,000. The aggregate amount appropriated upon this project, up to June 30, 1887, is $17,000.

Sixteen thousand six hundred and twenty-two dollars and fifty cents have been expended in all up to June 30, 1887, giving a through cut entirely across the bar with 12 feet low-water depth, and with a variable width of from 80 to 100 feet. The commerce of the harbor is now about the same as in 1880, no special increase being expected until the present improvements here are completed. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The special work of the year is as follows: Expenditures, $4,636.46; value of plant, $271. One hired dredge was in use during a part of the year. No work was done from August, 1885, to February, 1887, for want of funds.

The amount appropriated up to August, 1886, was too small for economical work, but work was then commenced because improvement was so much needed that small immediate results were regarded as more valuable than larger but delayed possible results.

Under an existing contract with Mr. Cephas Gilbert, of Georgetown, work was continued from June 30, 1885, to August 13, 1885, when it had to stop for want of further funds.

As soon as practicable after new appropriations became available the dredging was contracted for (with Mr. C. Gilbert, January 27, 1887), to be completed during 1887. Between February 16, and May 17, under this contract, 7,614 cubic yards of sand and mud, 54 stumps, (measuring 120 feet in total diameter), and 97 cubic yards of small stumps, roots, and snags, were removed from the channel-bed; completing a cut entirely through the bar from Sampit River to Winyaw Bay, 2,640 feet long, at least 12 feet deep everywhere at low water, and 100 feet wide over 1,940 feet length, and 80 feet wide over the entire length. Further work had to be stopped for want of the further much-needed funds.

A tide-gauge record was kept during the working season.

A careful inspection of property was made at the end of the year. This work has been carried on with great vigor and thoroughness under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows: That the above improvement be completed in accordance with the present approved and adopted project, so as to secure a channel of 12 feet depth at mean low water, and of about 200 feet bottom width, entirely through the bar, at a total expense of $25,000 in addition to the funds available June 30, 1887; this amount to be appropriated in one sum. Smaller yearly appropriations involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by about $2,000 per appropriation.

The channel once thoroughly opened will probably be permanent. By this improvement ocean vessels of 12 feet draught, after once crossing the Winyaw Bay Bar, can proceed without further delay 15 miles farther to their anchorage at Georgetown.

This improvement, as regards cost and order of work, should be carried on as follows:

The present channel should be at first widened throughout to 100 feet width, next to 120 feet width, and so on, each successive addition to the channel width being carried through the entire length of cut. The removal of stumps must accompany or follow immediately the removal of mud and sand. Immediate improvement is so necessary that any appropriation, however small, should be immediately utilized.

Georgetown is a port of entry.

Money statement.

July 1, 1886, amount available		$13.96
Amount appropriated by act approved August 5, 1886		5,000.00
		5,013.96
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886	$4,626.46	
July 1, 1887, outstanding liabilities	10.00	
		4,636.46
July 1, 1887, amount available		377.50
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging in harbor at Georgetown, S. C., opened at 11.30 a. m., November 9, 1886.

No.	Names and addresses of bidders.	How measured.	Price per cubic yard.	Remarks.
			Cents.	
1	Rittenhouse Moore, Mobile, Ala			Bid withdrawn in person at the opening.
2	W. H. W. Morris, New York, N. Y	In scows.	16	

Mr. Morris was allowed to withdraw his bid without prejudice and no contract was made.

Abstract of proposals for dredging in Georgetown Harbor, South Carolina, received January 10, 1887.

No.	Name and address of bidder.	How measured.	Price per cubic yard.
			Cents.
1	Cephas Gilbert, Georgetown, S. C	In scows	30

Contract with Cephas Gilbert.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

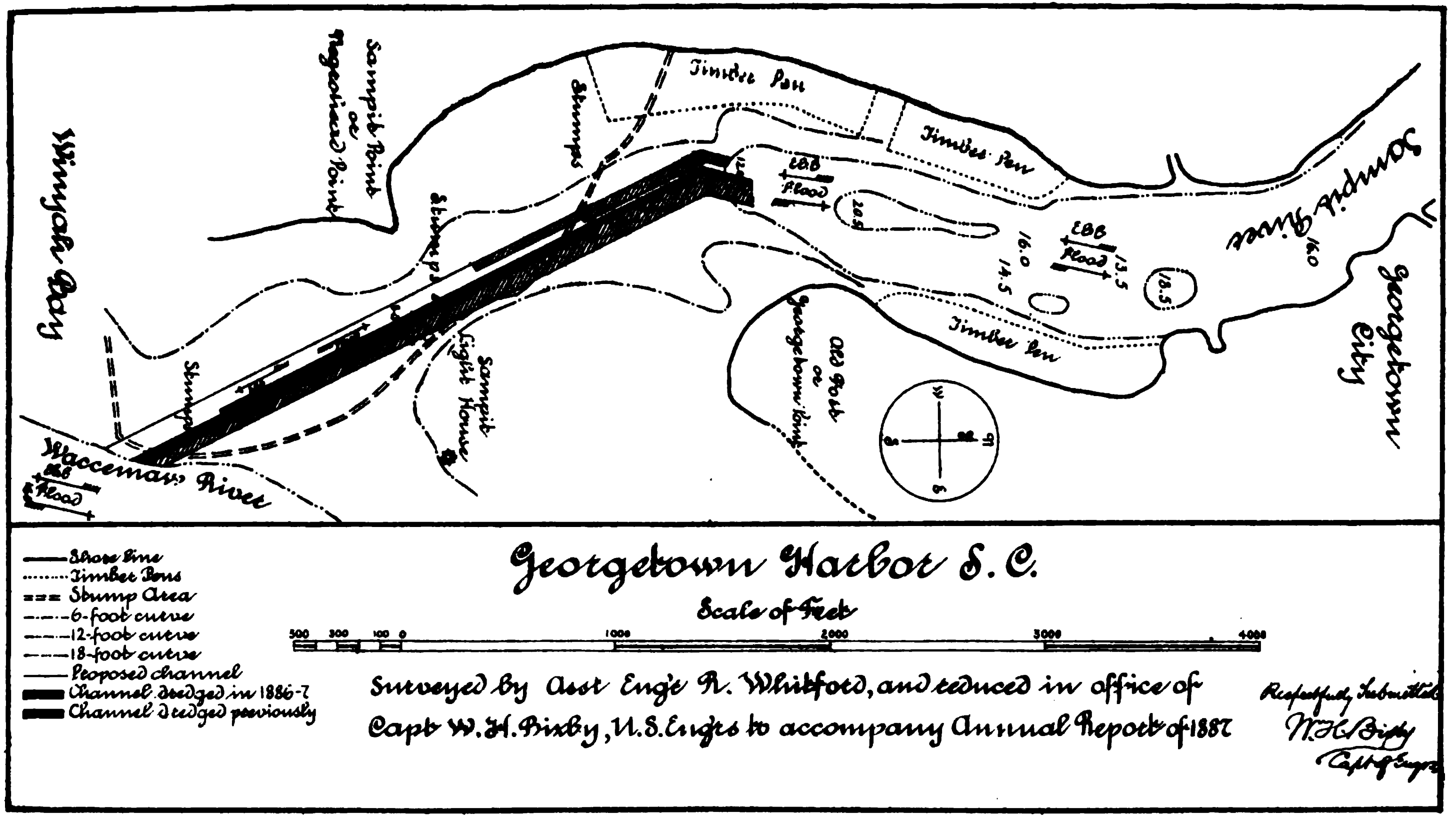
UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 15, 1887.

CAPTAIN: I have the honor to make the following report of operations upon this harbor for the fiscal year to date:

The contract was awarded to Cephas Gilbert, of this place, for dredging in the mouth of Sampit River The work consisted in widening the channel previously excavated at this point by the United States.

The contractor begun work February 16, 1887. The funds having been exhausted, operations were suspended on May 17, 1887. During this time there was removed by the dredge the following material: 7,613.72 (exclusive of that which was removed below the depth of 12.5 feet at low water, for which the contractor was not paid) cubic yards of sand and mud, 119.7 diametrical feet of large stumps, and 97 cubic yards of small stumps, roots, and snags.

The work added 40 feet in width to the narrow channel (40 feet), with 12 feet clear depth at mean low water already existing through the shoal. Besides this, another cut of 20 feet width was carried within about 700 feet of the deep water in Winyaw



Georgetown Harbor S. C.

Surveyed by Asst Eng'r R. Whitford, and reduced in office of Capt W. H. Bixby, U.S. Eng'rs to accompany Annual Report of 1887

Respectfully Submitted
W. H. Bixby
Capt of Engrs

Bay. The dredged channel has now a clear width of 80 feet, the channel lines as dredged being straight, and with this width it is believed that it can now be used to considerable advantage during daylight for the purpose for which it was intended, viz, to allow vessels leaving Georgetown at low tide to go to sea, 16 miles distant, on the following high water. Since the completion of this year's work a vessel drawing 11.5 feet left the wharf at Georgetown and actually made the trip as above. Nothing of the kind was ever done before—a strong evidence of the improvement. Heretofore, owing to the existence of the bar at the mouth of the Sampit, between the deep water of the bay and that at the wharves of Georgetown, vessels drawing 12 feet were compelled to cross this bar during a *high water*, and then to wait until the next high water before they could get to sea. This being the case, there can be no doubt about the improvement so far accomplished by the United States.

During October and November last a careful survey was made over the ground previously dredged. Each sounding within the channel lines was located by an angle from the shore, measured with a transit, cutting the ranges at the points as designated by the soundings. The soundings appearing outside of the channel lines were not so carefully located or plotted. The map of this survey, which is respectfully sent herewith, supersedes all former maps furnished by this office covering the same area at the mouth of the Sampit River. It shows the dredging done during the present fiscal year and that done previously.

There being no facilities for the storage of row-boats while not in use belonging to this work and other works, and a shelter of this kind being very much needed for the protection of the boats, an ordinary boat-house was constructed at Georgetown for the joint use of all boats belonging to the works under this office. The improvement of this harbor came in for a small share of this expense, having a clinker-built boat to be stored.

COMMERCE.

Mr. John I. Hazard, one of Georgetown's most active business men, who has very kindly furnished the commercial statistics for this work for the past several years, has now informed me that he thinks the amount of commerce for the fiscal year just ending is so nearly the same as it was for the calendar year ending December 31, 1886, that it would be safe to report here the commerce as reported for the calendar year as below.

* * * * * * *

It is respectfully recommended that next year's work be carried on as in the past, under the present approved project, and that the widening of the channel through the shoal at the mouth of the Sampit River be continued—each cut being carried entirely through before a new one is commenced, till it shall have reached the full width of 200 feet, as contemplated by the approved project.

Mr. William C. Johnstone filled very acceptably the place as inspector of this work during the present year.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When the improvement was recommenced, in 1881, the harbor had an excellent, well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth, but with an entrance bar allowing only 9-foot-draught boats to pass at low water. The commerce is now estimated to have then been about $4,000,000 per year, carried by seven steamers, two tugs, and thirty ocean schooners and ships. No work on the improvement was commenced until 1884, for want of funds.

At present the improvement is still incomplete. A narrow passage of at least 80 feet width and 12 feet depth has been cut through the bar. The commerce is now estimated at $5,000,000 per year, carried by nine steamers, two tugs, and thirty ocean schooners and ships.

The work so far done has had but little effect on commerce. No effect can be expected until the improvement is completed.

The rates of freight and insurance are as yet not affected.

The completion of this improvement will add considerably to the commerce of Georgetown, and will lessen rates of insurance and freight. The presence of this inner bar at Georgetown Harbor, taken in connection with the outer bar at Winyaw

Bay, causes a delay of at least two days to vessels entering and leaving Georgetown. The removal of the Georgetown Bar will shorten this delay to one day. Georgetown is the natural harbor and sea-port of 18,000 square miles of fertile lands belonging to the Sampit, Waccamaw, and Pee Dee River basins. The development of northern South Carolina requires that Georgetown Harbor be given a deeper channel and better communication to these rivers and to the ocean.

The commerce of this harbor for the year ending December 30, 1886, is estimated as follows:

Articles.	Quantity.	Amount.
Cotton .... bales	31,000	$1,240,000
Spirits turpentine .... barrels	27,000	432,000
Rosin and tar .... do	160,000	160,000
Rice (rough) .... bushels	100,000	100,000
Rice (cleaned) .... barrels	30,000	450,000
Lumber .... feet	5,000,000	75,000
Shingles .... number	6,000,000	30,000
General merchandise	....	15,000
General merchandise (mainly return freights) .... tons	50,000	1,500,000
Total	....	4,002,000

M 15.

IMPROVEMENT OF WINYAW BAY, SOUTH CAROLINA.

This bay is the natural and only ocean entrance to Georgetown Harbor and to the Sampit, Black, Great Pee Dee, Waccamaw rivers and their tributaries, with their 500 miles of navigable river, 18,000 square miles of drainage area, and present $5,500,000 of annual commerce. When the existing Mosquito Creek (Santee River), Congaree, and Wateree river improvements are completed, Winyaw Bay will become the entrance to the river basins of one-sixth of North Carolina and one-third of South Carolina, with about 900 miles of navigable river, 34,000 square miles of drainage area, and $12,000,000 of annual commerce.

This bay, prior to governmental improvement in 1886, possessed only 9 feet least depth of water upon its bar entrance; but a 12-foot channel the rest of the way to Georgetown. The volume of water moving through the throat of this bay at mid-ebb daily, at an average velocity of 2.1 feet per second, is sufficient to actually maintain at this point a channel of 4,000 feet width and 21 feet average depth; so that by the proper expenditure of money there should be no difficulty in obtaining a good bar entrance with 15 to 20 feet depth at low water. The commerce of the bay is estimated to have then been from $5,000,000 to $6,000,000 per year.

The original estimates of 1885, as continued to date, proposed for $2,500,000 to secure a permanent bar entrance of 15 to 20 feet depth at low water; and the original project of 1885 recommended an immediate appropriation of $300,000 toward this work. The aggregate amount appropriated for this project up to June 30, 1887, is $18,750.

Two thousand five hundred and seventy-five dollars and forty-two cents has been spent in all upon this improvement up to June 30, 1887, in surveys and necessary preparations for work. No special increase of commerce has been thereby obtained, and none is expected until $200,000 has been expended. The latest reliable commercial statistics, those for the year ending December 30, 1886, are herewith appended.

The special work of the year has been as follows: Expenditures, $2,575.42; value of United States plant, $196.

Owing to the difficulty of properly specifying it beforehand, measuring it afterwards, such work as was done was allowably done by hired labor and purchase of materials in open market.

During the fall and winter a careful survey was made of the area within which the projected dike was to be located, and a much less careful survey of the neighboring localities.

No further work was done, because it was not found practicable at present to make any economical and advantageous expenditure of the small sum of money so far available for this improvement.

A careful inspection of property was made at the end of the year.

Such work as was done has been thoroughly and vigorously carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows: That this improvement be carried on in accord with the original project of 1885 by the construction of stone dikes across the sloughs and along the inner edges of the bars until a good channel of at least 12 feet depth is obtained at one or both of the bar entrances, at a total expenditure, if necessary, of $2,700,000; this amount to be appropriated in annual installments of $300,000 each.

Various personal examinations of the locality and its surroundings have convinced me of the worthiness of this improvement (that of the outlet to the river basins of two-thirds of South Carolina) and the urgent need for large appropriations and rapid work. Smaller yearly appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, extra superintendence and care of plant, etc., and will increase the final cost by from $2,000 to $20,000 per year.

The improvement once thoroughly finished should remain comparatively permanent.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Twenty-five thousand dollars for five or more small wing dams or jetties to guard against future wear of the shores of North and South Islands on the flanks of the final main jetties.

Two hundred and seventy-five thousand dollars for the main North Island jetty.

Subsequent amonuts to be spent only after due consideration of the results of the work already done, as specially explained in the recommendations of the original survey and project of 1885.

This water-way is in the collection district of Georgetown, S. C.

Money statement.

Amount appropriated by act approved August 5, 1886		$18,750.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,521.35	
July 1, 1887, outstanding liabilities	54.07	
		2,575.42
July 1, 1887, amount available		16,174.58
Amount (estimated) required for completion of existing project		2,481,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 18, 1887.

CAPTAIN: I have the honor to make the following report of operations upon Winyaw Bay during the fiscal year to date:

A detailed survey was made at the entrance to Winyaw Bay, covering an area of about 6 square miles of water. Soundings and current velocities were taken all over this area, which are shown on original maps already forwarded to you. The object of the survey was to obtain necessary information in detail, which was not in existence, with the view of the future construction of stone jetties at the entrance to Winyaw Bay, the purpose of the jetties being to deepen the bar between the deep water in the bay and at sea. Afterwards the survey was extended up Winyaw Bay, in a rapid manner, to the mouth of the Sampit River, where the improvement of Georgetown Harbor is being carried on.

For use in the surveys a life-boat, 28 feet length over all and 6 feet beam, was built at Smithville, N. C. This boat has air-tight zinc tubes, 5 inches in diameter, running "fore and aft," on each side under the "thwarts." Her efficiency as a life-boat was severly tested in February last, having been caught in a cyclone when 3 miles at sea, with a full crew of 8 men on board. Her behavior in the breakers was all that could be wished. Finding it impossible to get to the windward with five oars, she was "scudded" for North Santee Point; while on this route she passed through 2 miles of breakers, only shipping about one barrel of water. The party all landed safely on Santee Point, and the boat was then hauled up without damage. In this same cyclone several boats belonging to outside parties were swamped and a vessel dismasted in the entrance to Winyaw Bay. Two of their men were drowned from one of the boats. I believe our whole party would have been lost had they been in any other row-boat in this vicinity.

A temporary boat house was built for the storage of boats belonging to this work, the house being paid for by all the works under this office owning row-boats.

There has been no other work done.

COMMERCE.

I would respectfully refer you to a communication from Mr. W. D. Morgan to myself, dated January 3, 1887, concerning this subject. For the past year there can be obtained no more reliable information regarding the commerce of Winyaw Bay than that given by Mr. Morgan. A copy of his communication, in print, is hereto attached. I fully concur in the views as expressed by Mr. Morgan.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

This bay is the ocean entrance to Georgetown Harbor, South Carolina.

No work has yet been done except a survey to see if there is any way of advantageously expending the inadequate funds now on hand. The present commerce of this bay is that of the Waccemaw, Pee Dee, Black, and Sampit rivers and Georgetown Harbor, a commerce of already $7,000,000 per year, carried by 200 ocean vessels and 2 steamers, making bi-weekly trips to Charleston. At the ocean bar there is at present only 9 feet depth at ordinary low water. Otherwise, navigation is practicable for boats of 12 feet draught. At present, however, vessels drawing no more than 10 to 12 feet are frequently detained for several days awaiting a flush high water to take them over the bar; and however great the distress in which a vessel may be while outside the harbor, no tug drawing over 7 or 8 feet can go to her assistance during low water.

Already Winyaw Bay is the outlet to $7,000,000 of annual commerce of the Sampit, Black, Pee Dee, and Waccemaw rivers. More than this, it is now connected by a 7-mile canal to the Santee River, so that it will soon be the shortest and most accessible outlet to $5,000,000 of annual commerce which will come down the Congaree, Wateree, and Santee rivers as soon as the railroad bridges over these rivers are properly furnished with draw-spans. These river basins at present raise over 400,000 bales ($16,000,000) of cotton per year. (See 1880 Census Reports.) These rivers are now navigable over 800 miles by steamers and over 1,000 miles by pole-boats. The amount of water now flowing in and out of Winyaw Bay at midtide is about 220,000 cubic feet per minute, sufficient to keep open a passage-way of 4,000 feet width and 21 feet average depth if provided with proper training-walls or dikes. All opinions of the Government engineers in charge of this work so far are to the effect that the bar is well worthy of improvement, and that it can be easily improved provided the necessary funds are voted in adequately large annual appropriations. An immediate appropriation of $800,000, properly spent, would undoubtedly develop at once an additional commerce of $8,000,000 per year.

Full statistics as to the commerce have been sought unsuccessfully, but those attainable give approximate estimates for the year ending 30th December, 1886, as follows:

Articles.	Number.	Amount.
Cotton .... bales..	40,000	$1,600,000
Spirits turpentine .... barrels..	85,000	560,000
Rosin and tar .... do ..	210,000	210,000
Rice (rough) .... bushels..	200,000	200,000
Rice (clean) .... barrels..	45,000	675,000
Lumber .... feet..	12,000,000	180,000
Shingles .... number..	13,000,000	65,000
General merchandise (mainly return freights) .... tons..	70,000	3,560,000
Total	....	6,990,000

M 16.

IMPROVEMENT OF SANTEE RIVER, SOUTH CAROLINA.

(For special history of past work, see page 1036, Annual Report for 1886.)

The Santee River, formed by the Congaree and Wateree rivers, and emptying into the Atlantic Ocean just south of Winyaw Bay, has from the sea to its headquarters in the mountains a total length of about 500 miles, and a drainage area of 15,414 square miles. It was formerly navigated by 4-foot draught boats from the sea up to Columbia on the Congaree and Camden on the Wateree.

In 1880, the date of the commencement of governmental improvement, the navigation was considerably obstructed and blocked at all stages of water by sunken logs, snags, and floating timber. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet depth of water at low tide, and so situated as to be very difficult and expensive to improve. Four steamers and a few small vessels were then running upon portions of the river. Its commerce is estimated to have then been about $600,000, and to now be about $1,400,000, of transported goods per year.

The original recommended project of 1880 proposed for $104,000 to provide the river with a good outlet through Mosquito Creek to Winyaw Bay, by deepening and straightening this creek to 50 feet width and 7 feet depth, at an expense of $74,000; and to secure a safe and unobstructed 7-foot navigation in the river itself from its mouth 154 miles upward to Wright's Bluff; and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers at an expense of $30,000. This estimate was based upon a hasty and inexpensive survey, which supposed very easy and cheap dredging and no need of revetment at Mosquito Creek, and comparatively few obstructions in Santee River. Subsequent work and examinations developed numerous cypress stumps and much hard sand to be removed, and much revetment to be put in at Mosquito Creek, and showed the river obstructions estimated for were far below the number per mile actually taken out from the similar neighboring rivers. In both cases the estimates should have been more than doubled to agree with facts later developed. A personal inspection of the entire river and work (made as soon as possible after assuming charge in 1884) revealed these facts and at the same time showed the importance and worthiness of the improvement. Besides the insufficient first estimates, I find that inadequate appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, deterioration of plant, etc.) have added considerably to the cost of the work. For all these reasons, the estimates for the final cost of the improvement were raised in 1886 to $346,500.

The appropriation of 1881 provided only for work upon the outlet of the river through Mosquito Creek to Winyaw Bay, and the smallness of the appropriation led to the temporary adoption of a modified project (that of 1881), which, as continued to date, proposed for $43,000 to secure to the river a straightened canalized outlet through Mosquito Creek, 7 miles long, 30 feet wide, and 6 feet deep at mean low water, and to construct one draw-bridge over this creek. For the same reasons as above explained, this estimate was raised in 1886 to $144,000 (with $5,000 additional for a tide-lock as required by Congress).

The aggregate amount appropriated upon this project up to June 30, 1887, is $75,750.

Sixty-nine thousand nine hundred and ninety-nine dollars have been spent in all upon this improvement up to June 30, 1887, in opening a passage at least 30 feet wide and 5 feet deep at high water from Mosquito Creek to Winyaw Bay; in making necessary surveys of the whole improvement, and in building a draw-bridge over the creek (in accordance with the provisions of the cession of right of way for the canal). No great improvement of commerce has yet been produced, nor was any to be expected therefrom until the canal should be finally completed. The latest reliable commercial statistics, those for the year ending December 30, 1886, are herewith appended.

The special work of the year is as follows: Expenditures, $14,652.63; value of United States plant, $405. No dredging was done between November, 1885, and October, 1887, for want of funds.

The amount of funds available at the commencement of the fiscal year was too small for economical work, but improvement was so much needed that small immediate actual results were regarded as more valuable than larger but delayed possible ones.

As soon as new appropriations became available, the dredging was contracted for (with Mr. Rittenhouse Moore, December 8, 1886), to be completed before May, 1887; but owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, other work was allowably done by hired labor and the purchase of materials in open market.

Between January 25 and March 24, 1887, 9,923 cubic yards of sand, mud, and roots, and 106.05 cubic yards of stumps, were removed from the canal in such a manner as to clear out all caved obstructions, to open it everywhere to 30 feet top width and 5 feet depth at low water, and to widen and deepen it to 30 feet bottom width and 6 feet depth over 1,790 feet length. The creek entrances are at present narrow, crooked, and shallow, so that when the canal was opened in November it will allow only rafts and boats of 75 feet length, 18 feet width, 3 feet draught at low water, to pass entirely through Winyaw Bay to the Santee River. The route is now in such condition that a steamer of 5 feet draught has lately, without difficulty, at high water, towed a lighter of 18 feet width through the canal from Winyaw Bay to the Santee and back.

During the year a certain amount of work was done in draining and diking the ground on the ocean side of the canal: 1st, to solidify and secure the stability of the canal embankment; 2d, to prevent as far as possible salt water from washing over from the ocean into the canal, from which it might pass to the neighboring rice fields, thus making the Government canal a source of injury to the rice interests; and 3d, to afford means for running off as rapidly as possible any ocean water that might reach the canal or adjacent ground during high or storm tides. The first object was sought by the use of small drains 3 feet wide on top, 2 feet deep, and 2 feet wide in the bottom, placed along the foot of all embankments and about 100 feet in rear of their crests. About 3,156 cubic yards of mud were removed from 12,625 linear feet of such drains. The second object was sought by the construction of a catch-sand fence, along and about 200 feet in rear of the crest of the ocean beach, to aid in raising the height of the beach against high tides; and also by the construction of a dike across Lagoon Creek which drained the lagoons into the canal. About 2 miles of fence, 3 feet high, was constructed in place, and has so far given good results, having caused the beach to rise from 1.5 to 3 feet along its entire length during the past year. Lagoon Creek was successfully barred by a clay and sand filled coffer-dam dike of 110 feet length, 20 feet width on top, 45 feet wide at bottom, and rising to about 4 feet above high-water level. The third object was sought by the construction of a large drain, 16 feet wide at top, 12 feet wide at bottom, and 2.5 to 3 feet deep from Lagoon Creek, through the lagoons and into Little Minim Creek which drains direct into the Santee River over a mile below Mosquito Creek. Seven thousand nine hundred linear feet of this drain was constructed by the removal of 1,672 cubic yards of mud. Between the lagoons and Little Minim Creek this drain passes through a wooden culvert (rice-field trunk) provided with automatic doors opening at ebb tide to drain the lagoons and closing during flood tide to keep out the rising water. These constructions, built according to the estimates and recommendations of the Annual Report for last year, have so far given most satisfactory results.

A minor survey of South Island, the canal, and the intervening ground and work, was made during the year with a view of obtaining a map suitable for properly recording and ordering work.

A series of inspections and special examinations were commenced in December, 1885, while the canal was open, in order to determine whether the opening of the canal had damaged or would damage the rice interests of the neighborhood by the introduction of salt or impure water. A full report of the result of these examinations was rendered on February 25, 1886 (since published in House Ex. Doc. No. 114, Forty-ninth Congress, first session). From March 26, 1886, the commencement of the rice-planting season, up to June 30, 1887, inspections of the canal have been very frequently made, and numerous samples of water at various points have been collected and bottled. These inspections commenced while the canal was open and continued after the canal was closed, and they have been supplemented by several special inspections, some made by a rice planter of long experience, some by the assistant engineer, some by myself, one of the latter having extended over the whole length of the canal at a moment when all conditions were most unfavorable to the pureness of the water in the canal, and on a day and even hour when special complaints were being made, the drainage of the adjacent rice lands. It proves further, that whenever a low stage of water exists in the Santee and its tributaries, as was the case last fall, the Santee is liable to be salt at its mouth, and consequently Mosquito Creek will also be salt, being supplied by the tides from Santee River, and situated only 3 miles from the Santee mouth, which opens immediately into the ocean.

PROTECTION AGAINST OCEAN WATER.

Active operations in the field were resumed in October, 1886.

A section of the South Island Beach for 2 miles had become so much reduced in height by the action of gales and the sand being swept off by high winds into the ocean, that every flush high water at sea crossed the sand beach, filling the neighboring marsh lands and lagoons with salt water. The United States Canal being in close proximity to the lagoons, and connected directly therewith by Lagoon Creek, it was possible that, under existing circumstances, this salt water might at times be drawn from the lagoons by the United States Canal and discharged into the Santee end of Mosquito Creek, to the damage of the rice under cultivation in the vicinity.

The following precautionary measures were taken by the United States to prevent any such damage actually occurring:

Catch-sand fence.—A fence of this kind was built along this 2 miles of low beach on South Island, with wings 8 feet long projecting at right angles to the general line of the fence and at intervals of 50 running feet. The whole fence is built in panels from 8 to 16 feet long, so that it might be raised whenever the drifting sands caught by the fence reached within a foot of the top. The top of the fence is 3 to 4 feet above the ground, and is constructed of 4 by 4 posts and inch boards, the boards being nailed on the posts 1¼ inches apart. Sufficient length of post is left below the bottom plank, so that when placed in the ground with the bottom plank one-half covered the whole fence shall have sufficient strength to stand erect and resist the force of ordinary winds. This work has been once or twice damaged by the large quantities of water being brought over the beach in strong gales before the fence in some places had caught sufficient sand to dam the water back. All the breaks in the fence have been repaired and its entire length raised since its original construction. Its action generally has been satisfactory, and it is believed that in a short time it will rebuild the beach to a considerable height.

Diking.—It next became necessary to guard against the ocean water which might cross the beach, in case the sand dunes formed by the fence were at any time broken through, and to prevent any of it entering the United States Canal.

This was accomplished by diking off Lagoon Creek at the Old Causeway, about 300 feet east of the United States Canal. The Old Causeway was built probably twenty-five years ago, and consists of a bank probably 20 feet wide at the base, with its top probably 3 feet above the high-water level, connecting two tongues of high land—the one reaching from South Island woods, and the other from Miller's, formerly Ford's, barn-yard. It is now covered with a growth of small trees and tough grass roots over its entire length.

The dike is about 70 feet long in the water and 40 feet on land. It is built of parallel rows of guide piles 12 by 12 inches and 10 feet apart; to these are bolted 12 by 12 inch mud and cap sills; 2-inch plank sheet-piles are driven down in the bottom of the creek against the inside faces of these sills.

The width of the dike is 20 feet, and has iron rods 1 inch in diameter passing entirely through it from side to side, which are screwed up tightly. The space between the rows of sheet-piles is solidly packed to the top with mud and clay, and the same material is banked against the outside of the sheet-piles, forming a slope of about 1½ feet to 1 foot from the bottom of the creek to the high-water line. This makes the total width of the bottom of the dike about 45 feet. Its extreme height is about 4 feet above the highest water level. All the material used in its construction is of the best quality, and all the wood work was treated to a coat of wood creosote oil. About 1,500 cubic yards of mud and clay were used as backing and filling. The work is thoroughly and strongly done, and it is believed the dike is a permanency.

Drainage ditches.—It next became necessary to dispose of the surplus water which might come across the beach and collect in large quantities against the dike, and which would not disappear quickly enough by natural evaporation. With this in view surveys were made and levels run from the lagoons to Little Minim Creek, a stream which enters the Santee River about 6,000 feet east of the mouth of Mosquito Creek. The result of the surveys proved that the surplus water might be easily disposed of by a drainage ditch being cut from the large lagoon to Minim Creek, a distance of about 7,900 feet.

A ditch 12 feet wide on bottom and 16 on top and from 2¼ to 3 feet deep, was begun in November last (1886), and completed in February, 1887, there having been removed from it a total of 9.672 cubic yards of mud. An old choked-up ditch on the south side of Ford's Avenue, running in the direction we wished to locate our drainge ditch, was taken advatage of, and our line carried along it. The length of this old ditch is included in the 7,900 feet given as the total length; and the cubic yards removed, in clearing out the old ditch to required dimensions, are included in the 9,672.

The excavated material from the drainage ditches was thrown on both sides. All that south of Ford's Avenue was scattered over the ground and leveled off. North of this avenue that which was thrown on the east side was leveled, but with that thrown on the west side a bank was dressed up 12 feet from the edge of the ditch about 6 feet on base, 4 feet on top, and about 4 feet in height. This bank extends from the avenue to the large lagoon, being continuous, except a break at the middle lagoon. The total length of dressed bank is about 4,200 feet.

To prevent the flood tide from Santee River backing up into the lagoons a drainage trunk (or culvert), such as used in irrigating rice lands, only larger, was bedded under Ford's Avenue, this being the highest land on the line, and, apparently to me, the proper place for its location. The trunk is 30 feet long, 12 feet wide, and 2½ feet deep (said to be the largest single trunk ever built in the county), and is fitted with automatic acting doors, so that it drains from the lagoons on the ebb tide and closes out the Santee water on the flood.

Along the United States Canal and the above-mentioned ditch embankments small drainage ditches, which are generally 3 feet wide on top and 2 feet wide on bottom and about 2 feet deep, were excavated. These ditches lead into the lagoons at the large drainage-ditch embankments, and into an old canal running into Little Minim Creek, and also at the other end into Lagoon Creek at the United States Canal embankment. Both ends of this ditch are provided with 6-foot wide trunks, to prevent the flood tide from entering. The object of these ditches is to prevent the water from puddling along the embankments and keeping them in a moist condition. That one along the drainage-ditch embankment was entirely completed, but that along the United States Canal embankment only partially, the work having been stopped on June 4, 1887, because of the low state of the funds, leaving a piece of this ditch near the middle excavated only to a depth of about 1 foot. This discrepancy in depth being near the middle or apex of the grade, the ditch does very good drainage work as it is, and can wait without harm till further money is appropriated for this work before its final completion. Total length of these small ditches completed, 2625 running feet, and total number of cubic yards removed are 3,156.

The action of the whole drainage system is most satisfactory, and is highly spoken of by all the citizens in the vicinity, even by those who have heretofore opposed the Mosquito Creek Canal improvement.

DREDGING UNDER THE APPROVED PROJECT OF WIDENING, DEEPENING, AND STRAIGHTENING THE SANTEE RIVER'S OUTLET INTO WINYAW BAY VIA MOSQUITO CREEK.

The contract for this work was awarded to Rittenhouse Moore. The dredge began operations on January 25, 1887, and stopped on March 24 following, the amount of money which was set aside for this particular portion of the work having been exhausted. The dredge during this time widened and deepened the existing canal on bottom to 30 feet and depth of water to 6 feet for 740 running feet at Lagoon Creek mouth of the canal: she then proceeded to the Santee end of the canal. Recommenced dredging there. The angle the canal makes by its intersection with Mosquito Creek was rounded off, and from there the canal was widened and deepened, as above, for a distance of 1,050 feet. This section of the line being full of cypress stumps, work was very expensive. While passing through the canal the dredge removed all the old caves, and put the canal in very good condition for navigation. The most stumpy portion of the ground was worked over, so that further dredging will be comparatively free from them.

The dredge removed a total of 9,922.7 cubic yards roots, mud, and sand, and 106.5 cubic yards of stumps.

Since the dredge ceased, several boats have gone through from Winyaw Bay to Santee River. A steamer drawing 5 feet, and towing a lighter 18 feet wide, passed to and from Santee without difficulty.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that work be done preferably: First, in deepening and widening Mosquito Creek where needed, and completing the small drainage ditch which was left unfinished, if it be found that it does not afford sufficient drainage in its present condition; afterwards widen, deepen, and extend the existing canal; then complete the other cut-offs included in the approved project.

SURVEYS.

An inexpensive stadia survey was made, from Santee, mouth of Mosquito Creek, to and around North Santee Point and up Minim Creek, thence with the drainage ditches to United States Canal, thence with United States Canal to its intersection with Mosquito Creek. The map which is respectfully sent herewith shows the work completed during the year, and that left to be done on the drainage ditches, and the existing canal.

All work finally ceased on June 16, 1887.

* * * * * * *

COMMERCE.

It is carried on by two steamers to Charleston, of about 300 tons each, and many small sailing vessels, pole flats, and rafts. You are respectfully referred to the commercial statistics for this river for the calendar year of 1886, which was forwarded to you in January last. No more reliable information than that can be obtained regarding this subject, for fiscal year of 1886–'87. It is expected that this amount will at once be largely increased by opening the Wateree and Congaree rivers to uninterrupted navigation, and by completing the passage, via Mosquito Creek, between Winyaw Bay and Santee River.

Steps are now being taken to construct a saw-mill at the Winyaw mouth of Mosquito Creek, for the purpose of sawing the cypress timber which will come from Upper Santee, through the United States Canal. Parties are at present engaged in getting cypress timber to be made into shingles for Mr. W. C. Lloyd, who operates a shingle mill here. In this way can be seen the benefit of the money expended by the United States in this improvement to the citizens of South Carolina, and to the community at large.

Mr. S. F. Burbank, inspector of this work, has my thanks for the cheerful and efficient performance of his duties.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work was commenced in 1880 the river was navigable for 6-foot draught boats at high water 154 miles up to Wright's Bluff, but the bar entrance to the river was narrow, crooked, shifting, and carried only 4 feet of water at low water. This bar entrance can not be improved except at great cost. The commerce is estimated to have then been about $600,000 per year carried by four steamers and a few small ocean schooners.

At present the navigation of the river is the same, all the money having been spent (as directed by Congress) upon making an outlet for the river to Winyaw Bay by means of a canal 7 miles long, 30 feet wide, and 6 feet deep at low water. This canal and its creek entrances are at present only improved so far as to allow the passage of boats 20 feet wide and of 3 feet draught. No marked increase of commerce is expected until this work is finished. The present commerce is estimated at about $1,400,000 per year.

The Santee River is itself the outlet to the commerce of the Congaree and Wateree rivers, which (as soon as draw-spans are placed in the South Carolina Railroad bridges) will hand over to it a commerce estimated at about $3,300,000 per year. Adding to this its own commerce of $1,400,000 per year, we find that it must be prepared within two or three years to carry a commerce of nearly $5,000,000 per year. This commerce demands a short and safe 6-foot draught outlet to the ocean, and the shortest and safest is by canal to Winyaw Bay. It is very important, therefore, that this canal be completed as soon as possible, and larger annual appropriations are necessary therefor.

Full statistics as to the commerce could not be obtained from the steam-boat companies; but those attainable give approximate estimates for the year ending December 30, 1886, as follows:

Articles.		Number.	Amount.
Cotton	bales	12,000	$480,000
Spirits turpentine	barrels	10,000	100,000
Rosin and tar	do	60,000	60,000
Rice	bushels	200,000	200,000
Shingles	number	2,000,000	10,000
Lumber	feet	3,000,000	30,000
General merchandise (mainly return freights)	tons	10,000	500,000
Total			1,440,000

M 17.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

(For special history of past work, see page 1057, Annual Report for 1886.)

The Wateree River, which unites with the Congaree to form the Santee, has (including its upper portion, called the Catawba) a total length of about 310 miles, and a drainage area of 5,642 square miles. This river, prior to governmental improvement in 1882, had a low-water depth of from 3 to 4 feet from its mouth in the Santee upward 68 miles to Camden, its practical limit of steam navigation. From its mouth upward 14 miles the river was completely blocked at all stages of water by sunken logs and stumps and by floating obstructions; thence [illegible]4 miles to Camden navigation was possible, but dangerous except during high water. Its commerce was then almost nothing.

The original project of 1881–'82, as continued to date, proposed for [illegible]4,000 to secure a safe and unobstructed 4-foot navigation over this entire distance at all stages of water. Inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work. For these reasons the estimates for the final cost of the work were raised in 1885 to $58,000, and now (1887) to $60,000. The aggregate amount appropriated for this project up to June 30, 1887, is [illegible]5,500.

Thirty-two thousand seven hundred and eighty-two dollars and ten cents have been spent in all upon this improvement up to June 30, [illegible]87, giving a thoroughly cleared 4-foot navigation at all stages of water from the mouth of the river 11 miles upward, and thence a fairly well cleared 4-foot navigation over the rest of the river 57 miles to Camden. In consequence of this improvement a steam-boat line would have been permanently established upon the whole length of the river had it not been prevented by the obstructions offered by two railroad bridges. Could these obstructions be removed, a river commerce of $1,000,000 of transported goods per year would be at once developed. A personal inspection of the river over its entire length (made as soon as possible after assuming charge in 1884) revealed these facts, and moreover showed me the agricultural richness of the river basin, its urgent need for water transportation facilities, and the worthiness of the improvement. The latest reliable commercial statistics (those for the year ending 30th December, 1886) are herewith appended.

The extent of this obstruction is shown by the following extract from special report, dated December 18, 1886:

> Eight miles above its mouth in the Santee, this river is crossed by the Camden branch of the South Carolina Railroad, on a wooden through bridge without a draw-span, the bottom of the bridge being 15.3 feet above low water. The use of this bridge without a draw has been specially authorized, as far as concerns the State of South Carolina, by State acts passed in 1853 and 1858.
>
> Thirteen miles above its mouth the river is also crossed by the Wilmington, Columbia and Augusta Railroad on a wooden deck bridge without a draw-span, the bottom of the bridge being about 17 feet above low water.
>
> The present improvement will probably be finished next year sufficiently to allow of a tolerably clear 4-foot navigation to steamers * * * over the whole river from its mouth up to Camden. The current of this river is swift and strong, especially during high-water stages. Both bridges have already proved serious obstructions to desired navigation.

> I therefore recommend that the owners of both these bridges be required to insert suitable draw-spans in their bridges; that the spans be at least 60 feet wide in the clear; that the opening be placed with reference to deep water and the convenience of navigation; that the openings be provided with strong and suitable fenders on both ends of the span, extending, say, 150 feet above and 80 feet below the bridge, and that these fenders should rise above ordinary high water to within about a foot of the draw-span's lower chord.

I would now modify the above recommendations so as to allow the Wilmington, Columbia and Augusta Railroad (if it so chooses) to dispense with a draw by raising its channel-span 21 feet, which can be readily done by converting its present deck-bridge into a through-bridge. This modification will place the bottom of the bridge 38 feet above low water.

The special work of the year has been as follows: Expenditures, $4,816.47; value of United States plant, $1,849. One hired steam-hoister was used during a portion of the year.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

No work was done on this river from April, 1885, to October, 1886, for want of funds. Work was resumed as soon as possible after new appropriations were available. Between November, 1886, and January, 1887, and from the entire length of the river up to Camden, 142 large logs, 63 stumps, 12 cords small snags, 5 old bridge piles were removed from the river channel; and 375 trees and 38.5 cords of brush (from 9,450 linear feet of bank) were removed from the river bank, so as to fairly clear the river over its entire length to 150 feet width and 4 feet depth at low water. Further work was stopped on this river to allow the hoister to work on the neighboring Congaree River, where improvement was more needed. During the year it became evident that it would be more economical and advantageous for the United States to own a hoister rather than to hire one, and during April, May, and June a steamer hoister was built for the combined use of this river and the Congaree.

A water-gauge record was kept during the working season.

A careful inspection of property was made at the end of the year.

The general charge of the work has been under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 4-foot navigation over the entire river at all stages of water, at a total expense of $24,500 in addition to the funds available June 30, 1887; this amount to be appropriated in one sum during the next year. Smaller yearly appropriations will increase the cost of the work by from $1,000 to $4,000 per appropriation.

It is further strongly recommended that the South Carolina Railroad be required to put a draw-span in its low through bridge across the river, and that the Wilmington, Columbia and Augusta Railroad be required to either insert a draw-span or to raise its present channel-span 21 feet.

Further improvement, so as to extend the navigation above Camden or to deepen that below Camden, is not recommended.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

The entire length of the river should be examined and improved uniformly each year.

During the low-water stage the most troublesome sunken logs and snags should be removed from the channel.

During the high-water stage the most troublesome leaning trees should be cut down and pulled back from the banks, as also such trees on caving banks as appear liable to fall into the river during the following year.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1886, amount available		$34.37
Amount appropriated by act approved August 5, 1886		7,500.00
		7,534.37
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,039.47	
July 1, 1887, outstanding liabilities	777.00	
		4,816.47
July 1, 1887, amount available		2,717.90
Amount (estimated) required for completion of existing project		24,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		24,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 20, 1887.

CAPTAIN: I have the honor to make the following report of operations upon this river during the fiscal year to date:

By agreement, Mr. H. S. Cordes furnished a self-propelling steam hoister, with which work was begun at the mouth of the river on the 1st day of November, 1886.

Operations were temporarily suspended by this hoister on January 31, 1887, in order that she might be put on the Congaree River for work there.

During this time, from November 1, 1886, to January 31, 1887, the river was worked over from its mouth to Camden and return, progress being occasionally retarded by high water.

The following obstructions were removed:

From the channel (roughly clearing it to 150 feet width and 4 feet deep more or less at low water):

Large logs	142
Stumps	63
Cords of snags	12.1
Piles from the old bridge near Camden	5

From the river banks:

Overhanging and other trees, which would soon fall in the river	375
Cords brush	38.5
Running feet of bank cleared	9,450

When the hoister was withdrawn the river was in a fair condition for navigation. There is still much left to be done on this river before the channel and banks can be said to be thoroughly cleared. The banks are caving badly in many places. Especially work needed for the first 7 miles above the mouth of the river, and for 3 miles after passing the Wilmington, Columbia, and Augusta Railroad Bridge, going up-stream.

It was deemed more economical and advantageous for the Government to continue this improvement and that on the Congaree River by owning the machinery required for the purpose. For this reason the steamer *M. W. Gary* was purchased from R. H.

Kellehan, of Georgetown County, and thoroughly overhauled, repaired, and supplied with hoisting engines and gear by Thomas W. Daggett, of Conway, S. C., under agreement. By these means she was converted into a very substantial and serviceabl self-propelling hoister. This boat is an entire success, and for this much credit is du Mr. Daggett, under whose personal supervision she was built from his own plans.

It is intended to resume work upon Wateree River during the coming autumn wit this machine.

RECOMMENDATIONS.

It is respectfully recommended that operations be continued in the same manner a heretofore on this river, namely, work up and down, over the whole length of th river included within the approved project, removing first such obstructions from th channel which seem to be most in the way of navigation during the low stages o water. When the water is too high to carry on this character of work to advantage then to cut from the banks overhanging and other trees which would soon fall in an form new obstructions. The work to be continued in this way till a channel of de sired width and depth shall have been thoroughly cleared.

COMMERCE.

As yet there is no established commerce on the river, the railroad bridges, whic are without draw openings, preventing anything of that kind. Several attempts hav been made to run steamers on this river to Charleston, but after meeting with man perplexing delays at the bridges, and the railroad companies persistently refusing t supply their bridges with the necessary draw openings, the enterprise was abandone The people all along the Wateree express themselves as being very anxious for stean boat navigation on the river.

Some of the people in Richland County are compelled to cross the river, which without bridges for vehicles in this vicinity, with their freights to get to the railroa which runs to Camden, or else haul 30 miles to other railroads.

Steamboats on the Wateree would give them communication with Charleston an Georgetown, with less hauling in wagons than they now have to do to get to an railroad.

If the river could be freely navigated there would, no doubt, at once be an annu commerce thereon worth at least $1,000,000.

I respectfully send herewith drawings of both bridges over the Wateree Rive They were made by Mr. William H. Johnstone, time-keeper, from his own measur ments. He has my thanks for the faithful and cheerful performance of his dut while time-keeper of the work.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1882 navigation was impracticable, and there was co sequently no river commerce.

At present there is no navigation, simply and solely because the South Caroli Railroad refuses to put a draw in its low continuous bridge.

Nothing but the railroad bridges of the South Carolina Railroad, and Wilmingt Columbia and Augusta Railroad prevent light-draught steamers from running all t year from Camden to the sea-ports of Georgetown and Charleston. The obstructi offered by these bridges to transportation is a serious obstruction to the developm of the neighboring country, and large portions of the fertile lands of Kershaw a Richmond counties west of the river are thus deprived of the proper transportati facilities to which they are justly entitled.

The Wateree flows through a rich country, and there is every reason to believe t the removal of the bridge obstructions will be rapidly followed by the establishm of a river commerce of from $500,000 to $1,000,000 per year, and by the rapid devel ment of the country adjacent to the river, a development which will quickly reimbu the railroads for any expense to which they might be subjected in the necessary m ifications of their bridges.

The estimated commerce of the first few years after the removal of the railroad bridges is as follows:

Articles.	Number.	Amount.
Cotton .... bales.	8,000	$400,000
Rosin .... barrels..	17,000	54,000
Spirits turpentine .... do....	4,000	60,000
Rice .... bushels..	50,000	62,500
Lumber, shingles, etc	......	50,000
Return freights .... tons..	10,000	500,000
Total	....	1,126,500

M 18.

IMPROVEMENT OF CONGAREE RIVER, SOUTH CAROLINA.

The Congaree River, formed by the Broad and Saluda rivers, and itself uniting with the Wateree to form the Santee, has (from the headwaters of its tributaries in the mountains down to its mouth in the Santee) a total length of about 250 miles and a total drainage area of about 8,312 square miles. The name Congaree applies properly to the 50 miles from the Santee upward to the confluence of the Broad and Saluda just above Columbia, S. C. This part of the river, prior to governmental improvement in 1886, had a low-water depth of from 3 to 4 feet from its mouth 48 miles upward to the railroad bridge at Columbia, and thence a 1-foot low-water depth 2 miles further to its head, the navigation of the lower 47 miles from the mouth upward to Granby being blocked at all stages of water mainly by the South Carolina Railroad bridge (without a draw), and secondarily by sunken logs, snags, overhanging trees, and the navigation of the upper 3 miles above Granby being prevented by its swift current and numerous rock ledges and bowlders. Its commerce was therefore nothing.

The original project of 1885 proposed for at least $30,000 to secure a thoroughly cleared 4-foot navigation below Granby at all stages of water, and estimated at $24,500 (not recommended for improvement at that time) the cost of a cleared 100-foot channel through the shoals above Granby. Now that the river has been roughly cleared over its entire length below Granby, and that there is no longer anything but the rock obstructions opposite Columbia to prevent the commerce of the Broad and Saluda rivers from going down the Congaree River to its mouth, the upper portion of the river appears to me worthy of immediate improvement by the General Government. A personal inspection of the locality, lately made by me, confirms these opinions. For these reasons, the original estimates of $54,500 are now recommended in full to secure a thoroughly cleared channel of 100 feet width and 4 feet depth at low water below Granby and of natural depth above Granby. The aggregate amount appropriated for this project up to June 30, 1887, is $7,500.

Four thousand eight hundred, ninety dollars and eighty-one cents has been spent in all upon this improvement up to June 30, 1887, giving a fairly well cleared 3-foot navigation at low water over the entire river below Granby. In consequence of this improvement a steam-boat line would have been at once and permanently established over the whole length thus cleared had it not been prevented by the obstruction offered by one railroad bridge. Could this obstruction be removed a river commerce of about $2,000,000 would undoubtedly be at once developed.

Several personal inspections of the locality have shown me the agricultural and commercial wealth of the neighborhood, the urgent need of water communication, and the worthiness of the improvement. The latest reliable commercial statistics, those of the year ending December 30, 1886, are herewith appended.

The extent of this obstruction is shown by the following extract from special report, dated December 18, 1886:

> Five miles above its mouth this river is crossed by the South Carolina Railroad, on a deck-bridge without a draw (and with a clear height of not more than about 25 feet above low water).
>
> The current of this river at this point is swift and strong, especially at high stages of water. I therefore recommend that the bridge-owners be required to insert a suitable draw-span in this bridge, that the span be at least 60 feet wide in the clear, that the opening be provided with strong and suitable fenders on both ends of this span, extending, say, 75 feet above and below the bridge, and rising above high water to within about a foot of the draw-span's bottom chord.

The special work of the year has been as follows:

Expenditures, $4,890.81. Value of United States plant, $1,785. One hired steam-hoister was used during a portion of the year.

Owing to its variable features, and to the difficulty of properly specifying it beforehand, and inspecting and measuring it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Work was commenced as soon as practicable after appropriations became available. Between January and April, and from the entire length of river up to Granby, 178 large logs, 140 stumps, and 4.5 cords of small snags were removed from the river-channel, and 314 trees and 7.5 cords of brush (from 12,800 linear feet of bank), were removed from the river bank, so as to fairly clear the river over its entire length to 3 feet depth at low water. At about this time it became evident that it would be more economical and advantageous to the United States to own a hoister rather than to hire one, and so further work of snagging was temporarily discontinued, and during May and June a steamer-hoister was built for the combined use of this river and the Wateree.

A water-gauge record was kept during the working season.

A careful inspection of property was made during the year.

The general charge of this work has been carried on thoroughly and vigorously under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

Recommendations for future work are as follows: That the improvement be completed in accordance with the original estimates of 1885, so as to secure a thoroughly cleared channel of 100 feet width and 4 feet depth at low water below Granby, and of natural depth above Granby 3 miles to the head of the river, at a total expense of $47,000, in addition to the funds available June 30, 1887, this amount to be appropriated at once in a single sum. Smaller appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, extra superintendence and care of property, etc., and will increase the cost of the work by from $2,000 to $6,000 per year. It is further strongly recommended that the South Carolina Railroad be required to put a suitable draw into its present continuous low through bridge across the lower portion of the river. Further improvement so as to deepen the river below Columbia or to give other transportation facilities opposite Columbia are not recommended at present.

After this improvement is finished, its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

The entire length of the river below Granby should be examined and improved uniformly each year by snagging the channel thoroughly during low-water stages, and clearing the banks thoroughly during high-water stages, removing especially such trees on caving banks and elsewhere as appear liable to fall into the river during the following year.

The river above Granby should be opened as soon as possible, first to 60 feet width everywhere, and subsequently to full width along a line of channel determined only after a careful survey of the river levels, slopes, and natural channels.

This river is in the collection district of Georgetown, S. C.

Money statement.

Amount appropriated by act approved August 5, 1886		$7,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,899.85	
July 1, 1887, outstanding liabilities	990.96	
		4,890.81
July 1, 1887, amount available		2,609.19
Amount (estimated) required for completion of existing project		47,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		47,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 20, 1887.

CAPTAIN: I have the honor to make the following report of operations upon this provement for fiscal year to date:

By agreement, H. S. Cordes furnished a self-propelling steam hoister (the same one ed on the Wateree River), with which work was begun at the mouth of the river on bruary 3, 1887, and continued till April 25 last, having then terminated the agreeent with Mr. Cordes. During this time the hoister worked over the river to "Old anby" Landing, near Columbia, S. C., to which point the improvement is limited, d return. The progress of the work was occasionally retarded by high water. The llowing obstructions were removed:

From the channel: 178 large logs, 140 stumps, 4.5 cords snags; roughly clearing it a width of 150 feet and depth of 4 feet, more or less, at low water.

The river banks were roughly cleared as follows: 314 overhanging and other trees, which would soon fall in the river; 7.5 cords brush, etc., and 12,800 running feet of ank cleared.

When operations ceased the river was then in a fair condition for navigation.

Mr. H. S. Cordes, superintendent of the South Carolina Steamboat Company, was n board the hoister when she went from near the mouth of the creek to "Old Granv." He, in a letter written to me, after the trip was made, said that "the water was foot above low water, and, with the exception of a few logs here and there, the river was easily navigable." However, there is still left much to be done before the channel nd banks can be declared *thoroughly* cleared of obstructions. The banks are badly aving at many points, which will soon cause the heavy growing timber to fall and gain choke up the channel, unless cut away. There are many logs and snags, too, the river which need to be removed. The points requiring more immediate attenon are between 5 and 10 miles and 25 and 35 miles above the mouth of the river. At present, the most formidable obstruction to navigation is the South Carolina Raiload bridge, situated about 5 miles above the mouth of the river, which is without draw or opening.

It was considered more economical and advantageous for the Government to conase this improvement, and that on the Wateree River, by owning the machinery quired for the purpose. For this reason, the steamer *M. W. Gary* was purchased m R. H. Kelleban, of Georgetown County, and was thoroughly overhauled, repaired, d supplied with hoisting engines and gear by Thomas W. Daggett, of Conway, S. under agreement. By these means she was converted into a very substantial and serviceable self-propelling hoister. This boat is an entire success, and for this much credit is due Mr. Daggett, under whose personal supervision she was built from his own plans.

It is intended to resume work upon the Congaree in next month with this machine.

RECOMMENDATIONS.

It is respectfully recommended that operations be continued on this river, as heretofore, viz, work up and down over the whole length of the river included within the approved project, removing such obstructions from the channel which seem to be most in the way of navigation during the low stages of water. When the water is too high for this character of work to be carried on to advantage, then to cut from the banks overhanging and other trees which would soon fall in and form new obstructions. The work to be continued in this way till a channel of desired width and depth shall have been thoroughly cleared.

COMMERCE.

At present there is no commerce on this river, this being the case because of the persistent refusal of the South Carolina Railroad Company to supply their bridge with the proper draw opening to allow the free and uninterrupted passage of steamers. Within the past two months the South Carolina Steam-boat Company have attempted to run their steamers between "Old Granby" Landing and Charleston, being encouraged to do so by the offer of freight along the river in sufficient quantities to pay them well. They actually brought down between 500 and 1,000 barrels of naval stores (the first freight carried over this river by steamers since the year 1845), but now they have abandoned the scheme, owing to the delays their boats are subject to at the railroad bridge.

The people along the river and in Columbia are particularly desirous of establishing navigation on the river, and they are taking active measures to cause the railroad company to open the bridge. I am informed that the South Carolina Steamboat Company have entered suit against the South Carolina Railroad Company for damages caused by the delay of their boats at the bridge. The Columbia people, and especially Col. S. A. Pearce, president of the Columbia Board of Trade, one of the most public-spirited and enterprising of Columbia's citizens, have from the beginning, and do now, manifest a marked interest in the improvement of the Congaree River by the United States Government.

If the river could be freely navigated there would doubtless at once be an annual commerce worth at least $500,000.

My thanks are due to Mr. William H. Johnstone, time-keeper of this work, for the faithful performance of his duties.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1885 there was no navigation at all on the river, and consequently no commerce.

At present there is no navigation, and none can be expected until the South Carolina Railroad puts a draw-span into its present continuous bridge across the river near its mouth.

As soon as money was voted for the improvement of the river the railroads of the neighborhood were reported to have put on more trains, reduced their rates, and extended their facilities for storing and handling goods.

This improvement is greatly needed and will be of great benefit to a large portion of South Carolina, and especially the country at the head of the river about Columbia. Columbia is reported for the year ending December 30, 1886, to have commerce of—

Articles.	Quantity.	Amount.
Cotton .... bales..	50, 000	$2, 000, 000
Naval stores........ barrels..	25, 000	25, 000
General merchandise........ tons..	450, 000	3, 300, 000
Total	....	5, 325, 000

The opening of the river will cause the country adjacent to the neighboring rivers to bring to Columbia large quantities of lumber, cotton ($4,000,000 more), grain, granite, naval stores, for water transportation to the sea-ports of Georgetown and Charleston; and the return freights (coal, iron, provisions, fertilizers) will add probably $2,000,000 to its commerce.

The prospective commerce of the river proper the first few years is estimated as follows:

Articles.		Quantity.	Amount.
Cotton	bales	25,000	$1,000,000
Naval stores	barrels	35,000	35,000
Return freights	tons	160,000	1,200,000
Total			2,235,000

This $2,000,000 river commerce is now completely prevented by the South Carolina Railroad, whose bridge, without a draw, will not allow the passage of steamers.

M 19.

REMOVING SUNKEN VESSELS OBSTRUCTING OR ENDANGERING NAVIGATION.

1. *Ship Clio and steamer North Heath in Cape Fear River, North Carolina.*—On February 16, 1886, the Board of Commissioners of Navigation and Pilotage of Wilmington, N. C., made formal complaint that there were two wrecks in the river below Wilmington which were within or on the edge of the channel and endangered or obstructed navigation.

Examination elicited the following information:

The British brig *Clio* was built at Prince Edward Island in 1861. She was a wooden vessel of 105 feet in length, 25 feet beam, and 12 feet depth. This vessel was loaded at Wilimington about the year 1871, and was wrecked on the Rip of Oak Island Channel, at the mouth of the river, 19 miles below Wilmington. After the cargo was taken out she drifted back into the river, burnt to the water's edge, and sunk at a point about a half mile above the Price's Creek light-house and toward the western side of Snow's Marsh Channel. In February, 1885, the wreck lay in from 11 to 13 feet depth of water. Portions of the wreck rose to within 4 feet of the water-surface and other portions descended to 20 feet below the water-surface.

The side-wheel steamer *North Heath* was a blockade runner during the late war. At or about the time of the capture of Fort Fisher, in 1865, she was taken by the Confederate authorities and sunk in the main channel of the river, near the head of Clark's Island, about 3 miles below Wilmington, as an obstruction to navigation. She was an iron side-wheel light-draught steamer of from 200 to 250 feet in length. Her upper works were above the water-surface for several years, and then certain parties, by the use of explosives, removed as much of the wreck as was profitable to them and left the remainder. In February, 1885, the wreck lay in from 17 to 20 feet depth of water. Portions of this wreck rose to within 7 feet of the surface and other portions descended to 23 feet below the water-surface.

The natural bottom in both places was mud, with accumulations of sand and mud around the wrecks.

There was supposed to be nothing about either wreck of any special value or specially worth saving.

In accordance with the provisions of section 4 of the act of June 14, 1880, thirty days' notice was given to all persons interested in these wrecks; and in default of the appearance of any such persons, the removal of these wrecks was duly advertised. Proposals were opened June 7, 1886, and a contract with the lowest bidder, the American Dredging Company, was approved on June 23, they agreeing for $7,500 to completely remove the wrecks within four months from the signing of the contracts.

Work was commenced by the contractor on July 14, and completed satisfactorily in September, 1886. The cost of the removal of both wrecks, including office expenses, advertising, inspection, etc., was $7,852.08; all expended in the fiscal year ending June 30, 1887. The reclaimed wreckage was afterwards sold at public auction October 23, 1886, for $656.15, and the receipts returned to the United States Treasury.

The provisions of section 4 of the act of June 14, 1880, require that in all such cases of the removal of such wrecks "all property therein when so removed shall, after reasonable notice of the time and place of sale, be sold to the highest bidder or bidders for cash, and the proceeds of such sale shall be deposited in the Treasury of the United States to the credit of a fund for the removal of such obstructions to navigation, under the direction of the Secretary of War." In this particular case the wreckage did not sell for the amount of money that its removal cost the contractor. Under such circumstances, the contractor was obliged to do a large amount of otherwise unnecessary labor in landing this property, and as his bid was of course based on the necessity of performing this otherwise unnecessary labor, the Government, in the end, was obliged to pay for the property much more than it received, and was the loser by the whole operation.

I am satisfied that in this particular case the proposals would have been much lower, and the final cost of removal of the wrecks much less, to the Government could the wreck have become the property of the contractor after its removal. Similar cases are liable to happen often in the removal of sunken vessels which obstruct the navigation of our rivers. I have therefore to recommend that the act of the 14th of June, 1880, be so modified as to allow the Secretary of War, before advertising the removal of the wreck, to decide whether or not the property when removed shall belong to the contractor or to the Government. In my opinion, some such modification would result in economy to the Government.

2. *Steamer Wave, in Beaufort Harbor, North Carolina.*—In December, 1886, the collector of Beaufort Harbor, North Carolina, made formal complaint that the steamer *Wave* was wrecked in Beaufort Harbor in such position as to endanger and obstruct navigation.

A personal examination confirmed the report.

In accordance with the provisions of section 4 of the act of June 14, 1880, thirty days' notice was given to all persons interested in this wreck; and in default of the appearance of any such persons, the removal of the wreck was duly advertised. Before the date for opening bids, the owner of the steamer appeared and removed the wreck at his own expense. The cost of this work to the United States (including office expenses, advertising, etc.) was $10, all expended in the fiscal year ending June 30, 1887.

M 20.

PRELIMINARY EXAMINATION OF LOCKWOOD'S FOLLY RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following report upon the examination of Lockwood's Folly River, North Carolina, assigned to me by river and harbor act of August 5, 1886, and letters from your office dated September 27, 1886, and October 28, 1886.

This report is based upon my own personal inspection of the locality and various reports which I have received from various persons living on this river and which I have checked by my own personal knowledge f the case.

Lockwood's Folly River is a river of about 50 miles length and 180 square miles of drainage basin, lying wholly in Brunswick County. It rises at a point about 16 miles southwest of Wilmington, N. C., flows first westerly, then southerly, and empties into the Atlantic Ocean at a point about 15 miles west of the mouth of the Cape Fear River.

At its ocean bar its channel depth is about 3 feet at low water and 8 feet at high water; from the bar to a point 1½ miles above its mouth its depth is about 8 feet; for the next 300 or 400 feet its depth is only about 1 to 1½ feet at low water, owing to the presence of a narrow belt of oyster rock reaching entirely across the river; for the next 1½ miles its depth varies from 3 to 6 feet, with a bottom of alternate mud and oyster rock; for the next 22 miles its depth is from 8 to 15 feet at low water, and for the next 15 miles its depth is from 5 to 8 feet at low water. oasting schooners of 300 barrles capacity and 6 feet draught enter the river from the ocean at favorable tides, and go 25 miles up the river. At the head of schooner navigation the river is still about 150 feet wide. From this point pole-boats carry merchandise 15 miles further. The river is crossed by one bridge at the head of schooner navigation, and by another bridge at the head of pole-boat navigation.

At present the commerce of the river is small. The exports (crude and manufactured turpentine, tar, wood, light-wood, lumber, shingles, cotton, rice, corn, rye, oats, hay, cabbages, collards, turnips, sweet potatoes, Irish potatoes, beans, peas, ground-peas, melons, sugar cane, sirup, fish, oysters, diamond-backed terrapin) are estimated at $25,000 per year, and the imports (general merchandise) at $25,000 more; total, $50,000 per year.

These goods are carried away by schooners, two of which endeavor to make weekly trips to Wilmington. The oyster rock barrier, combined with unfavorable tides, often detains these schooners for six to ten days, so that regular trips become an impossibility, and the commerce in consequence suffers severely. Owing to the difficulty of getting goods to market, only about 6,000 acres of upland and about 1,000 acres of swamp land are at present under cultivation.

The Lockwood Folly River basin, is, comparatively speaking, good agriculturally. It embraces about 80,000 acres of good uplands, capable of producing $30 of ordinary crops per acre, and about 40,000 acres of good swamp lands capable of producing $40 of ordinary crops per acre, representing $4,000,000 of possible annual crops, all lying within 5 miles of the navigable portions of the river. Besides this agricultural wealth, the river basin contains a large quantity of pine, oak, ash, poplar maple, hickory, gum, cypress, and juniper standing timber. Were the obstructions removed from the mouth of this river, the annual commerce would undoubtedly soon reach $400,000 per year, a gain over the present of about $375,000 per year.

The needed improvements are: (1) the removal of the oyster rock barricade near the mouth of the river; (2) the dredging of a channel through the flat just above this barricade; and, (3) the improvement of a short-existing cut-off in the river about 5 miles from its mouth. Ten thousand dollars will give valuable results; $40,000 will certainly complete all improvements needed for several years, and would put this river basin in immediate good communication with the ocean.

In my opinion the probable increase in the commerce of this river and in the development of its basin render this river worthy of improvement by the General Government.

The exact location and cost of the improvement can only be determined by a special survey. The cost of this survey is estimated at $200.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

W. P. CRAIGHILL,
Colonel of Engineers.

SURVEY OF LOCKWOOD'S FOLLY RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

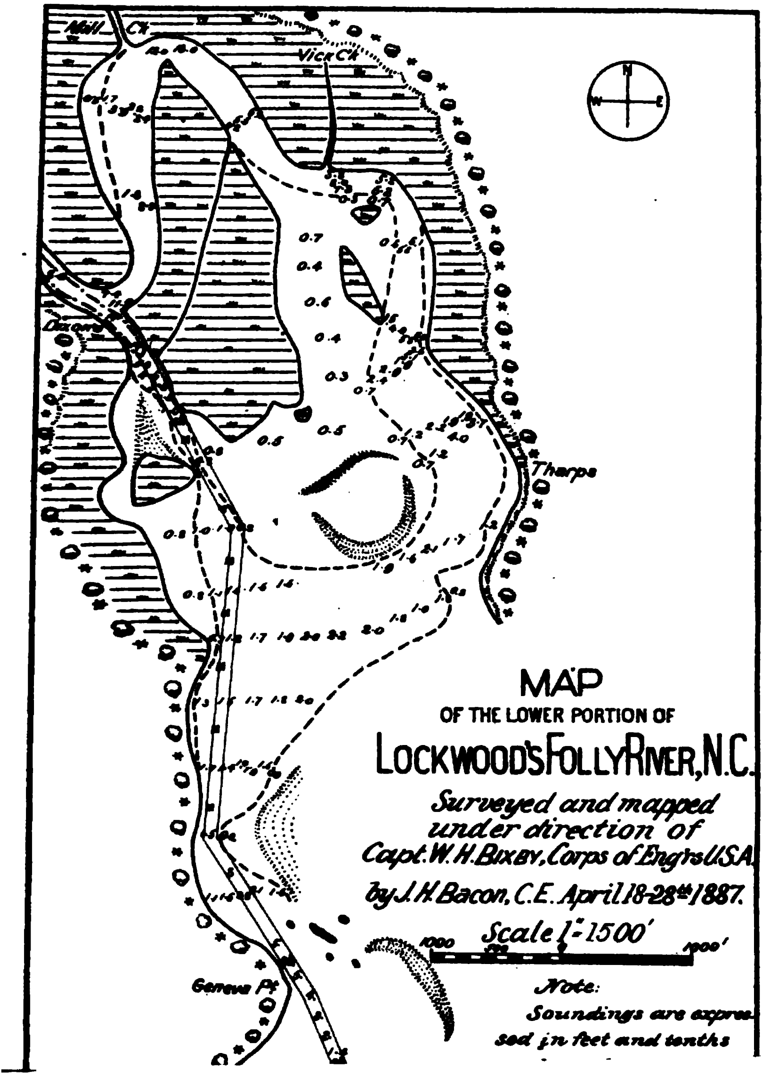
GENERAL: In accordance with instructions from your office, dated March 16, 1887, and the river and harbor act of August 5, 1886, I have herewith to submit my report upon the survey of Lockwood's Folly River, North Carolina, with a project for its improvement and an estimate of the cost of such improvement.

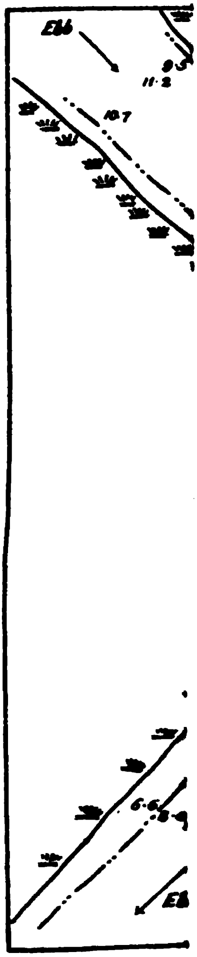
This project and estimate of cost are based upon a survey of the portion needing improvement as made by Mr. J. H. Bacon and as checked by an inspection of the entire locality by myself in a canoe.

The present commerce of this stream (as explained in full in my report of February 4, 1887, on its examination) is only about $50,000 of transported goods; but 80,000 acres of good upland and 40,000 acres of good swamp lands, representing $4,000,000 of possible annual crops, lie within 5 miles of this stream, and the development of $350,000 of annual commerce may be expected as soon as the river obstructions are removed.

The entire amount estimated as necessary to clear this river might be most advantageously spent in a single year.

I have therefore to recommend that $40,000 be appropriated in a single sum for the improvement of Lockwood's Folly River, North Carolina, by dredging through the oyster-rock barricade and mud flats at the mouth of the river, and elsewhere, if necessary, so as to establish a


Mill Ck
Vick Ck
N
W
E
Dixons
Tharps
Geneva Pt
MAP
OF THE LOWER PORTION OF
LOCKWOOD'S FOLLY RIVER, N.C.
Surveyed and mapped
under direction of
Capt. W. H. Bixby, Corps of Eng'rs U.S.A.
by J. H. Bacon, C.E. April 18-28th 1887.
Scale 1" = 1500'
1000
1000'
Note:
Soundings are expressed in feet and tenths


Ebb
9·5
11·2
10·7
6·6
8·
E

6-foot-draught free navigation from the ocean upward to the bridge at the present head of schooner navigation. This river, tidal throughout its lower 25 miles, is obstructed mainly, if not entirely, because of an oyster-rock barricade just above its mouth. The nature, extent, location of proposed channel, and estimate of its cost are quite fully shown in the maps and report of Mr. Bacon, herewith inclosed. Mr. Bacon deserves credit for far greater care and thoroughness both in survey and maps than I had any right to expect in view of the limited funds at his disposal. His estimates were necessarily based upon a low-water level, obtained from local observations made during his survey, and were computed for exact depths of 4 and 6 feet, without any allowances for exceptionally low water, for free way under vessels, or for usual slight occasional overdredging. In order to be certain of securing a 6-foot-draught navigation, it will be necessary to allow for dredging a 7-foot channel according to Mr. Bacon's survey. In my opinion the interests of commerce here demand such a 7-foot channel of 100 feet width. This 7-foot channel will require about—

130,000 cubic yards dredging sand and mud, at 20 cents	$26,000
24,000 cubic yards dredging shell rock, at 30 cents	7,200
	33,200
Superintendence and contingencies, 20 per cent	6,640
Total	39,840

Small and irregularly voted appropriations will probably greatly increase the final cost of the work.

Respectfully submitted.

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. J. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., May 3, 1887.

CAPTAIN: I have the honor to submit the following report of the survey of Lockwood's Folly River, North Carolina, and the estimates for channels 100 feet in width and 6 feet and 8 feet depth, from the ocean to the head of navigation.

The field-work of the survey was begun on April 18, 1887, and finished on April 28, 1887. In accordance with instructions received at your office, the shore-lines were located by means of compass bearings and stadia measurements, and the soundings by means of a 500-foot line, each line of soundings being measured from a known point. A map on the scale of 1,000 feet to the inch was made in the field during the progress of the survey. Maps on the scale of 100 feet to the inch were also made of Mercer's Cut and the Cross-rock Shoals. All of these are herewith submitted.

The depth of water over the bar is somewhat variable. There is said to be generally 6 feet at low water in the channel. From the inside of the bar to Howell's Point there is an available channel of 8 feet at low water and one of 6 feet to the lower end of Cross-rock Shoals. From this point to the Goss Cut, a distance of 1⅛ miles, there is an available channel of only 1 foot at low water. From the Goss Cut to the head of navigation at Lockwood's Folly Bridge, there is said to be an available channel of 8 feet or over at low water. Of this latter portion, only the vicinity of Mercer's Cut was surveyed. This cut is 260 feet long, 25 feet wide, and has an available depth of 3 feet at low water. It is not, however, essential to the project, as the natural channel at this point has a depth of 8 feet at low water.

The maximum velocity of the stream is apparently 3 miles per hour, except at a point in the middle of the Cross-rock Shoals, where on the ebb tide it attains a velocity of apparently 6 miles per hour.

The tide was observed daily during the progress of the survey, the gauge being located at Sharp's Landing, 3 miles from the ocean. The average range of the tide during the time of observation was 2.14 feet.

The bottom of the proposed channel is composed of mud, sand, and shell rock. From the lower portion of the Shell-rock Shoals to Geneva Point the bottom is continuously composed of shell rock. I have no definite knowledge of the thickness of this rock, but have estimated it at an average of 2 feet. The material beneath the rock is probably mud. This shell rock is composed of oyster shells closely packed together. The cost of removing it will not greatly exceed the cost of dredging hard sand.

For 1,500 feet north from Geneva Point the bottom is sand. The remainder is very soft mud, with the exception of a small patch of shell rock, which is situated about 500 feet from the lower end of the Goss Cut.

The estimated cost of dredging is as follows:

For a channel of 6 feet depth and 100 feet width from the ocean to the head of navigation:

Sand and mud, 96,167 cubic yards, at 20 cents	$19,233.40
Shell-rock, 20,097 cubic yards, at 30 cents	6,029.10
	25,262.50
Engineering and supervision, 10 per cent	2,526.25
Contingencies, 10 per cent	2,526.25
Making a total of	30,315.00

For a channel of 8 feet depth and 100 feet width from the ocean to the head of navigation:

Sand and mud, 160,446 cubic yards, at 20 cents	$32,089.20
Shell-rock, 24,666 cubic yards, at 30 cents	7,399.80
	39,489.00
Engineering and supervision, 10 per cent	3,948.90
Contingencies, 10 per cent	3,948.90
Making a total of	47,386.80

Very respectfully, your obedient servant,

J. H. BACON,
Civil Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

M 21.

PRELIMINARY EXAMINATION OF LUMBER RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following report upon the examination of Lumber River, North Carolina, assigned to me by river and harbor act of August 5, 1886, and letters from your office, dated September 27, 1886, and October 28, 1886.

This report is based upon my own personal inspection of the locality and upon various reports which I have received from various persons living along this river and which I have checked by my own personal knowledge of the case.

Lumber River is a river of about 250 miles length, and about 1,860 square miles of drainage basin. It rises at a point about 60 miles southwest of Raleigh and on the division line between Moore and Montgomery counties, North Carolina, then flows in a general southeasterly and afterward southwesterly direction through or along Richmond, Cumberland, Robeson, Bladen, and Columbus counties, North Carolina, and

Marion and Horry counties, South Carolina, and empties into the Little Pee Dee River at a point about 160 miles from the Atlantic Ocean.

Flats and boats able to navigate the Lumber River can proceed from its mouth down the Little Pee Dee and Great Pee Dee to Georgetown, S. C., where their goods are reshipped to coastwise or foreign ports. In its straight reaches its banks are high, rising occasionally to bluffs of 60 feet height; in its crooked narrows its banks are low and swampy and overflowed during freshets and even ordinary high water. From its mouth upward 23 miles to Fair Bluff the channel is at least 90 feet wide and 6 feet deep at ordinary stages of water, and at least 4 feet deep at low water; from Fair Bluff upward 65 miles further to Lumberton the channel is at least 40 feet wide and 5 feet deep at ordinary water, and 3 feet deep at low water; for the next 55 miles to the Cape Fear and Yadkin Valley Railroad the channel is at least 40 feet wide and 5 feet deep at ordinary water; for the next 32 miles to Pike the channel is at least 30 feet wide and 5 feet deep; and for the next 40 miles to Patterson the channel is at least 20 feet wide and 5 feet deep at ordinary water; and for the next 44 miles to its head the channel is gradually reduced to nothing. During six months of the year 185 miles of this river from Pike to its mouth is navigated by rafts and flats; and rafts of 160 feet length, 15 feet width, 2 feet draught, and containing 40,000 feet of timber, and flats of 50 feet length, 11 feet width, 2½ feet draught, and carrying 20 tons of rosin or cotton, are poled down this river to the Great Pee Dee River and Georgetown. The river is crossed by eight bridges between its mouth and Lumberton, and by twenty more bridges above Lumberton. The location of these bridges and the dimensions of the river between these bridges is shown in some detail in the accompanying table. At present the commerce of the river is small. Only about 200 rafts ($30,000 of goods) pass down the river each year. The Lumber River basin is comparatively rich, agriculturally. From its head to Lumberton the river basin is comparatively well served on both banks by the Raleigh and Augusta, Cape Fear and Yadkin Valley, and Carolina Central railroads. Below Lumberton about 50,000 acres of excellent land, capable of producing $2,000,000 of possible annual crops, and lying within 5 miles of the west bank of the river, is at present, comparatively speaking, unused, because the farmers are obliged to transport their goods by land and rail, so far as to reduce their profits in many cases to almost nothing. The river over this length is well adapted to service by a small stern-wheel 30-ton boat, such as is in use on neighboring streams, providing that the river were once properly cleared. Were the river so cleared, its commerce would probably be at once increased by about $300,000 per year.

The needed improvements are merely the removal of logs and snags from the river bed, and of overhanging trees from the river banks on the 98 miles of river below Lumberton; $29,000 in one sum would complete all the improvements needed on this length of river for several years, and, taken in connection with the proposed work on the neighboring Pee Dee River, would put this river basin in immediate communication with the ocean.

In my opinion, the probable increase in the commerce of this river and in the development of its basin, render this river worthy of improvement by the General Government from its mouth 98 miles upward to Lumberton.

The cost of the improvement can be estimated and a project at once submitted *without any further special survey*, *unless* this project must be accompanied by a careful map of the river. If a careful map of the river, within the limits of the recommended improvement, must accompany the estimate and project, a special survey will be necessary. The cost of this special survey is estimated at $700.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

Bridges across Lumber River, North Carolina.

Name of bridge.	Distance from mouth of river by water.	Least channel-way during ten months of year.		
		Interval.	Width.	Depth.
	Miles.	*Miles.*	*Feet.*	*Feet.*
Nichols	2	2	90	6
W. and C. R. R.	10	8	100	6
Fair Bluff	33	23	90	6
Griffin's Bluff	50	17	40	6
Ives' Bluff	64	14	80	6
Phillip's	78	14	40	6
Matthew's	82	4	40	6
Carolina Central R. R., lower	98	16	40	5
Lumberton, lower	98			
Lumberton, upper	98			
Carolina Central R. R., upper	104			
McNeill's	108			
Sampson's	112			
New	117			
Harper's Ferry	126			
Red Banks	136			
Three Carolina Central R. R. trestles	145			
Alma	146			
Cape Fear and Yadkin Valley R. R	153	55	40	5
Campbell's	157			
McGirt's	165			
Gilchrists'	175			
Pike	185	32	30	5
Raleigh and Augusta R. R	205			
Keyser	205			
Paterson's	225	40	20	5
Head of river	249	44		

SURVEY OF LUMBER RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

GENERAL: In accordance with instructions from your office dated March 16, 1887, and the river and harbor act of August 5, 1886, I have herewith to submit my report upon the survey of the Lumber River, North Carolina, with a project for its improvement, and an estimate on the cost of such improvement.

This project and estimate of cost are based upon an inspection of the entire portion of the river recommended for improvement; this inspection having been made by myself, in person, by canoe. The river, having a gentle slope of scarcely more than 3 inches per mile, possesses somewhat of the character of a canal, and its navigation up to Lumberton is only obstructed by leaning and fallen trees and sunken obstructions. The characteristics of the stream at various points, and the cost of its improvement below Lumberton, are shown in the following table:

Distances.		Name of locality.	Observed.								Reported height of water then above dead low water.	Estimate of cost of improvement by snagging and clearing.
			Water-way.			Curvature of river.		Banks.				
Miles from mouth Little Pee Dee.	Interval, miles.		Width of stream.	Depth in channel.	Current, per hour.	Number of bends per mile.	Diameter of bends.	Height on north-east or right side.	Height on south-west or left side.	Height of high-water mark.		
			Ft.	*Ft.*	*M.*		*Feet.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
	4	Lumberton	90	6	1	9		8	8	8	2	$800
	2	High Bluff	100	5				3-25	5	6	2	400
	1	Washout Swamp	40-70	6+	1	6	200-1,000	1	1	3	2	300
		Tar Kiln Bluff							2			
	2	Narrows	40	6+	2	6-13	150-800	0-1	1-0	2	2	600
	1	Pope's Landing						2	2			200
	1	Horse Bluff						2	2			200
	5	Narrows	40-70	5	1½	5-9	50-1,200	0-1	1-0	2	2	3,500
	....	Matthew's Bluff	90	6+			3,000	15	1			
	4	Narrows	40-70	6	1½	5-9	50-1,200	0-1	1-0	2	2	2,000
	....	Phillip's Bridge										
	14	Narrows	40-110	6+	2	5-9	50-1,200	0-1	1-0	2-6	2	4,200
	....	Ives' Bluff						12	6			
	5	Narrows	100-150	6+	½	1-2	100-5,000	8-3	1	6	2	1,000
	4	Narrows	80-120	6+	1-2	5-9	200-2,000	0-3	3-0	3		1,200
	5	William's Landing	80	6+				0	8	3	2	1,000
	2	Griffin's Bluff	120	6+	1½	Straight		90	4	4	2	400
	7	Narrows	30-80		1-2	5-9	80-1,000	2	2	3		3,500
	1	Narrows	90-120	6+	1	1-2	100-5,000	1-2	2-1			300
	7	Narrows	90	6+	1	2-9	200-8,000	1-2	2-1	4	2	2,100
	3	Fair Bluff	180			1-2		5	10	4		600
	20	Narrows	90-130	6+	1½	2-9	100-5,000	1-3	3-1	5	2	5,000
	....	Wilmington, Columbia and Augusta R. R.	150					0-2	2-0	6	2	
	10		90-210	6+		2-9	200-8,000	1-18	6-1	6		2,000
	....	Mouth	200	6+	1			1-0	0-1	5	2	
												29,300
		Superintendence and contingencies, 20 per cent										5,860
		Total										35,160

The present commerce of this stream (as explained in full in my report of February 4, 1887, on its examination) is only about $30,000 of goods transported by rafts and pole-boats; but below Lumberton and on the sides of this stream, and within 5 miles thereof, lie about 50,000 acres of excellent land, representing $2,000,000 of possible annual crops, this land being at present almost unused, because in many cases the farmers are obliged to transport their goods to market by land and rail such a distance as to reduce their profits to almost nothing. The river from Lumberton to its mouth is well adapted to a service by small stern-wheel 30-ton boats, such as are now in use on neighboring streams, and the development of a commerce of over $300,000 may be expected as soon as the river is once properly cleared. This improvement, in connection with the also recommended improvement of the Little Pee Dee River, will put this river basin in immediate communication with the ocean.

I am informed that private parties have, during the past year, obtained from the State a charter to the navigation of this river, and the right to collect tolls thereon.

The entire amount estimated as necessary for clearing the river might be advantageously expended in a single year.

I have, therefore, to recommend that $35,000 be appropriated in a single sum for the improvement of the Lumber River, North Carolina, by clearing it for a 4 to 6-foot draught steam navigation from its mouth upward to Lumberton, N. C.; providing that none of this amount be expended upon this work until all rights to the exclusive navigation of this stream shall have been ceded to the United States free of charge.

Small and irregularly voted appropriations will probably greatly increase the final cost of the work.

Respectfully submitted.

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 22.

PRELIMINARY EXAMINATION OF MINGO CREEK, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following report of the examination of Mingo Creek, South Carolina, assigned to me by river and harbor act of August 5, 1886, and letters from your office dated September 27, 1886, December 23, 1886, and October 28, 1886.

This report is based upon my own personal inspection of the locality and various reports which I have received from various persons living on this creek, and which I have checked by my own personal knowledge of the case.

Mingo Creek, South Carolina, is a river of about 45 miles length and 200 square miles of drainage basin, lying wholly in Williamsburgh County, South Carolina. It rises at a point about 12 miles east of Kingsville, S. C., flows in a general southeasterly direction, and empties into Black River at a point about 41 miles (by water) from Georgetown, S. C. From the mouth of the Mingo downward to the Atlantic Ocean there is already a freely navigable channel of at least 400 feet width and 9 feet depth at low water. From the mouth of the Mingo upward 10 miles to Rhem's Landing the present channel is at least 150 feet wide and 10 feet deep at low water; from Rhem's Landing 7 miles further to Mingo Bridge it is at least 120 feet wide and 7 feet deep; from Mingo Bridge 4 miles further to William's Landing it is at least 80 feet wide and 5 feet deep at low water; from William's Landing 10 miles further it is from 4 to 5 feet deep at high water. A steamer of 80 feet length, 30 feet width, 5½ feet depth hold, and about 80 tons burden, at present makes bi-weekly trips from Georgetown to Rhem's Landing. This steamer has occasionally gone up the river as far as Mingo Bridge, and could go up as far as William's Landing were it not for obstructing logs and trees. The river is crossed by one bridge at Mingo Bridge, and this bridge is provided with a draw-span.

At present the actual commerce of the river is estimated at about $157,000 of goods upwards per year and about $208,000 of goods downwards per year; total, about $365,000 per year. (See accompanying detailed statement furnished by F. Rhem & Sons, of Black Mingo, S. C. All this comes from the lower portion of the river, the upper portion (Indiantown, Cooper, Poplar Hill, Church, Rome) being at present obliged to haul their goods by land so far as to reduce their profits in many cases to almost nothing. The Mingo Basin is, comparatively speaking, rich agriculturally. It embraces about 200,000 acres, of which about 100,000 acres, capable of producing $4,000,000 of possible annual crops, lies within 5 miles of those portions of the river which would be navigable if cleared of logs and trees. Were the obstruction removed the annual commerce would probably be at once increased by about $150,000 per year.

The needed improvements are merely the removal of logs and snags from the river-bed, and of overhanging trees from the river banks. Fifteen thousand dollars in one sum would complete all improvements needed for several years, and would put this river basin in immediate communication with the ocean.

In my opinion, the probable increase in the commerce of this river and in the development of its basin render this river worthy of improvement by the General Government.

The cost of the improvement can be estimated and a project submitted *without any further special survey*, *unless* this project must be accompanied by a careful map of the river. If a careful map of the river, within the limits of the recommended improvement, must accompany the estimate and project a special survey will be necessary. The cost of this special survey is estimated at $300.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

Estimated annual commerce of the Black Mingo River, South Carolina, 1886.

DOWNWARDS.

Articles.	Quantity.	Value.	Total value.
Spirits turpentine..........barrels..	4,500	$18.00	$81,000
Crude turpentine..........do....	2,000	2.50	5,000
Rosin..........do....	18,000	2.00	36,000
Cotton..........bales..	800	40.00	32,000
Rice (rough)..........bushels..	500	.70	350
Peas and corn..........do....	500	.70	350
Ground-nuts..........do....	200	.90	180
Vegetables..........	....	....	500
Hides and furs..........number..	2,000	.50	1,000
Shingles (cypress)..........M..	500,000	10.00	50,000
Light wood..........cords..	500	3.00	1,500
Oak, pine, etc..........do....	500	2.00	1,000
Total downward..........	....	....	208,880

Estimated annual commerce of the Black Mingo River, South Carolina, 1886—Continued.

UPWARD.

Articles.	Quantity.	Value.	Total value.
Guano ....tons..	200	$30.00	$6,000
Hay........................bales..	400	1.55	620
Barrels (empty, spirit)........................number..	4,500	1.70	7,650
General merchandise and machinery ....tons..	2,950	....	143,000
Total upward	....	....	157,270
Grand total........................	....	....	366,150

SURVEY OF MINGO CREEK, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

GENERAL: In accordance with instructions from your office, dated March 16, 1887, and the river and harbor act of August 5, 1886, I have herewith to submit my report upon the survey of Mingo Creek, South Carolina, with a project for its improvement, and an estimate of the cost of such improvement.

This project and estimate of cost are ased bupon an inspection of that portion of the river recommended for improvement, this inspection being made by myself in person by horse and carriage to points of the river recommended to be cleared for pole-boat navigation and by steam-launch over the portion recommended to be cleared for steam-boats. This stream having a gentle slope of scarcely more than 3 inches per mile, possesses somewhat of the character of a canal; and its better navigation, within the limits of the recommended improvement, is only obstructed by leaning and fallen trees and sunken obstructions. The characteristics of the river, as a whole, are stated in my report of February 4, 1887, upon its preliminary examination; and fuller detail of the 21 miles to be cleared for steamboats, and the cost of the entire recommended improvement from its mouth up to the head of useful navigation, are shown at length on the accompanying map. The estimate of total cost is as follows:

From its mouth to Rhem's Landing (10 miles, at $330)........................	$3,300
Thence to Williams's Landing (11 miles, at $660)........................	7,260
Thence for pole-boats (10 miles, at $330)........................	3,300
	13,860
Superintendence and contingencies (20 per cent.)........................	2,772
Total........................	16,632

The present commerce of this stream (as explained in full in my report of February 4, 1887, on its preliminary examination) is already about $365,000 per year, but about 100,000 acres of good lands, representing $4,000,000 of possible annual crops, lie in the fertile basin of the Mingo, and within 5 miles of those portions of the river to be cleared of logs and trees; and a development of $150,000 more commerce may be expected as soon as the river is once fairly cleared. This improvement, in connection with the already existing good navigation in the Lower Black and Great Pee Dee rivers, will put the Mingo River Basin in direct communication with the ocean.

The entire amount estimated as necessary for clearing this stream might be advantageously expended in a single year.

I have therefore to recommend that the $17,000 be appropriated in a single sum for the improvement of Mingo Creek, South Carolina, by clearing it for a 9 to 5 foot-draught steam navigation to Williams's Landing, and thence for a 5 foot-draught winter pole-boat navigation up to the head of such useful navigation.

Small and irregularly voted appropriations will probably greatly increase the final cost of the work.

Respectfully submitted.

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 23.

PRELIMINARY EXAMINATION OF CLARK'S CREEK, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following report of the examination of Clark's Creek, South Carolina, assigned to me by river and harbor act of August 5, 1886, and letters from your office dated September 27, 1886, December 23, 1886, and October 28, 1886.

This report is based upon my own personal inspection of the locality and various reports which I have received from various persons living in the neighborhood of this creek, and which I have checked by my own personal knowledge of the case.

Clark's Creek is, properly speaking, the southern mouth of Lynche's River. Its head is in Lynche's River, about 1½ miles from the latter's northern mouth in the Great Pee Dee River; it flows 12 miles in a general southerly direction and empties into the Great Pee Dee River about 12 miles below the northern mouth of Lynche's River. From the mouth of Clark's Creek downward to the Atlantic Ocean there is already a freely navigable channel of at least 250 feet width and 8 feet depth at low water. During the greater part of the year this creek is a stream of from 100 to 200 feet width, 9 to 12 feet depth, with banks rising from 4 to 8 feet above the water-surface, and at that time becomes the main mouth of Lynche's River. During extreme low water sand-shoals, formed over and around sunken logs, reduce the dimensions of the stream to from 50 to 200 feet width and from 2 to 6 feet depth.

At all times at present the navigation of Clark's Creek is rendered impossible by its numerous overhanging and fallen trees, and sunken logs, trees, and snags.

The topography of the vicinity of the mouth of Lynche's River is such that it would be exceedingly difficult if not impossible to keep open the northern mouth of this river, since at every freshet this northern mouth forms a natural collecting-basin for the drift-wood of the Great Pee Dee River. On the other hand, it would be very easy to keep open Clark's Creek, the southern mouth of Lynche's River, provided that the northern mouth were permanently closed. Since Clark's Creek is the only practicable permanent mouth of Lynche's River, its commerce depends upon that of Lynche's River. Lynche's River is a river of about 160 miles length, and 1,365 square miles of drainage-basin. It flows through a very fertile portion of South Carolina. The country bordering on the lower 50 miles of river has no profitable outlet for its crops unless by water to the Great Pee Dee River. It is estimated that at least $100,000 of timber alone would have gone out of Lynche's River last year had Clark's Creek been open. As soon as Clark's Creek is opened large quantities of cotton, naval stores, and other crops will come down, and large quantities of fertilizers and general merchandise will go up Lynche's River on flats and lighters.

The needed improvements are merely the closure of the northern outlet of Lynche's River by the felling of trees from its banks and the opening of Clark's Creek by the removal of logs and snags from its bed, and of overhanging trees from its bank; $7,500 in one sum would complete all improvements needed for several years, and would put Lynche's River in immediate communication with the ocean. In my opinion, the probable increase in the commerce of Lynche's River and in the development of its basin, render Clark's Creek worthy of improvement by the General Government.

The cost of this improvement can be estimated and a project submitted *without any further special survey*, *unless* this project must be accompanied by a careful map of the creek. If a careful map of the creek, within the limits of the recommended improvement, must accompany the estimate and project, a special survey will be necessary. The cost of this special survey is estimated at $140.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer, Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

SURVEY OF CLARK'S CREEK, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

GENERAL: In accordance with instructions from your office dated March 16, 1887, and the river and harbor act of August 5, 1886, I have herewith to submit my report upon the survey of Clark's Creek, South Carolina, with a project for its improvement, and an estimate of the cost of such improvement.

This project and estimate of cost are based upon an inspection of the entire portion of the stream recommended for improvement, this inspection having been made by myself in person on foot along the banks or in canoe. This creek, having a gentle slope of scarcely more than 3 inches per mile, possesses somewhat the character of a canal, and its navigation at present is only obstructed by leaning and fallen trees, and by drift and sunken obstructions. The characteristics of the stream are fully described in my report of February 4, 1887, on its preliminary examination, and full details as to the widths, depths, etc., and as o the cost of the recommended improvement are shown at length on he accompanying map.

The present commerce of this stream (as explained in full in my report of February 4, 1887, on its preliminary examination) is nothing; but this stream is the only practicable outlet of Lynche's River, a river of 160 miles length and 1,365 square miles of drainage-basin, and a development of from $200,000 to $300,000 commerce may be expected as soon as Clark's Creek is once fairly cleared. This improvement, in connection with the existing improvement of the Great Pee Dee River, would put the Lynche's River basin in immediate communication with the ocean.

The entire amount estimated as necessary for clearing this stream might be advantageously spent in a single year.

I have, therefore, to recommend that $7,500 be appropriated in a single sum for the improvement of Clark's Creek (the outlet of Lynche's River), by clearing it over its entire length for a 4-foot steam navigation to connect the Lynche's and Great Pee Dee rivers.

Smaller and irregularly voted appropriations will probably greatly increase the final cost of the work.

Respectfully submitted.

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 24.

PRELIMINARY EXAMINATION OF LITTLE PEE DEE RIVER, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit the following report upon the examination of Little Pee Dee River, South Carolina, assigned to me by river and harbor act of August 5, 1886, and letters from your office dated September 27, 1886, and October 28, 1886:

This report is based upon my own personal inspection of the locality and upon various reports which I have received from various persons living along this river, and which I have checked by my own personal knowledge of the case.

The Little Pee Dee River is a river of about 220 miles' length and about 1,200 square miles of drainage basin. It rises in Richmond County, North Carolina, at a point about 80 miles southwest of Raleigh, and flows in a general southerly direction along or through Marlborough, Marion, and Horry Counties, South Carolina, and empties into the Great Pee Dee River about 60 miles from the Atlantic Ocean. From its mouth to the Atlantic Ocean there already exists a navigable channel of at least 150 feet width and 9 feet depth at low water.

The Little Pee Dee River, at ordinary stages of water, is a comparatively sluggish stream, with alternate straight reaches and crooked narrows; in the reaches, the stream being wide, deep, sluggish, and bordered by high banks; in the narrows, being shallow at crossings, of quicker current, and with low, swampy banks, overflowed during freshets, and even ordinary high water. From its mouth upward 4 miles it is from 200 to 400 feet wide and 5 feet deep at ordinary water, and subject to a tidal rise and fall of 3 inches; for the next 9 miles its channel is at least 80 feet wide and 6 feet deep; in the next 17 miles, by the existence of obstructing trees and divided channel-ways, its channel is in places reduced to 35 feet width and in others to 3 feet depth at ordinary waters; for the next 24 miles the channel is at least 100 feet wide and 6 feet deep; for the next 14 miles, up to Gallivant's Bridge, the channel is, as before, reduced in places to 35 feet width and in others to 4 feet depth; for the next 26 miles, up to the mouth of Lumber River, the channel is from 40 to 400 feet wide and at least 6 feet deep at ordinary waters; for the next 64 miles, up to Little Rock, the channel is at least 30 feet wide and 3 feet deep at ordinary waters; and for the next 64 miles, to its head, the channel is gradually reduced to nothing. Prior to the late civil war, light-draught steamers used to ascend the river 94 miles to the mouth of the Lumber River, and during seven months of the year, for the last seven years, flats 52 feet long, 14 feet wide, 30 inches draught, capable of carrying 20 tons of rosin or cotton, have been poled down 134 miles of the river from Campbell's Bridge to its mouth, whence their cargoes were carried to other points on the Great Pee Dee or to Georgetown. This river is crossed by one bridge between its mouth and the mouth of Lumber River, and by eight more bridges between that point and Little Rock. The location of these bridges and the least dimensions of the river between these bridges is shown in some detail in the accompanying table.

At present the actual commerce of this river is small, being estimated at its best at 32,000 barrels of naval stores, 15,000 bales of cotton, 400,000 feet of ton timber, 100,000 shingles, and various farm products, amounting to about $100,000; all of which must be poled down the river in rafts. The Little Pee Dee basin is, comparatively speaking, rich agriculturally. According to the last census of 1880 the townships along its banks possessed a population of 21,000, and raised an annual crop of $770,000 of cotton and grain, in addition to large quantities of naval stores. The commerce of Little Rock is to-day about $200,000 exports (mainly cotton) and $150,000 imports (mainly fertilizers and general merchandise). The commerce of Gallivant's Ferry is to-day about $60,000 exports (mainly cotton and naval stores) and $50,000 imports (fertilizers and general merchandise). From Little Rock to the mouth of the river there are about 200,000 acres of excellent land, capable of producing $8,000,000 of annual crops, lying within 8 miles of the river, which would be rapidly developed if the farmers could only get their goods to market with certainty and ease.

The Little Pee Dee River over this whole length has a tolerably uniform and gentle slope, such that its current rarely exceeds 2 miles an hour except during freshets. If it were once properly cleared it would be well adapted for use as a natural canal for pole-boats from Little Rock to the Lumber River, and for a small stern-wheel 30-ton boat the rest of its way to its mouth. Were the river so cleared, its commerce would probably be increased at once by at least $400,000 per year.

The needed improvements are merely the removal of logs, trees, and snags from the river-bed and of obstructing and overhanging trees from its banks, the occasional widening of present natural cut-offs, and the obstruction of unnecessary channels, so as to open steam navigation to the mouth of the Lumber River and pole-boat navigation from there to Little Rock. Forty-two thousand dollars in one sum would complete all the improvements needed on this river for several years, and would place this river basin (and the Lumber River basin also) in immediate communication with the ocean.

In my opinion, the probable increase in the commerce of this river and in the development of its basin render this river worthy of improvement by the General Government from its mouth 158 miles up to Little Rock.

The cost of this improvement can be estimated and a project at once submitted *without any further special survey*, *unless* this project must be accompanied by a careful map of the river. If a careful map of the river, within the limits of the recommended improvement must accompany the project, a special survey will then be necessary. The cost of this special survey is estimated at $1,000.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

Bridges across Little Pee Dee River.

Name of bridge.	Distance from mouth of river by water.	Least channel-way during nine months of the year.		
		Interval.	Width.	Depth.
	Miles.	*Miles.*	*Feet.*	*Feet.*
Gallivat's Ferry	68	68	35	8
Gilchrist's	96	28	40	6
Wilmington, Columbia and Augusta Railroad	98	2	30	3
Allen's	110	12	40	4
Huggin's	118	8	40	4
Carmichael's	124	6	45	4
Campbell's	134	10	50	4
Stafford's	150	16	60	4
Little Rock	158	8	50	4
Head of river	222	64	....	....

SURVEY OF LITTLE PEE DEE RIVER, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

GENERAL: In accordance with instructions from your office dated March 16, 1887, and the river and harbor act of August 5, 1886, I have herewith to submit my report upon the survey of the Little Pee Dee River, South Carolina, with a project for its improvement and an estimate of the cost of such improvement.

This project and estimate of cost are based upon an inspection of the entire portion of the river recommended for improvement, this inspection having been made by myself in person, by horse and carriage, to the principal points of its upper 60 miles to be cleared for pole-boats, and by canoe or steam-launch over the entire portion to be cleared for steamboats. This river, having a gentle slope of scarcely more than 3 inches per mile in its lower 98 miles, possesses somewhat of the character of a canal, and its navigation within the limits of the recommended improvement is only obstructed by leaning and fallen trees and sunken obstructions. The characteristics of the river, as a whole, are stated in my report of February 4, 1887, upon its preliminary examination; and fuller details of the 94 miles to be cleared for steamboats and the cost of the entire recommended improvement below Little Rock are shown at length on the accompanying map.

The present commerce of this stream (as explained in full in my report of February 4, 1887, on its preliminary examination) is only about $100,000 of goods transported by rafts and pole-boats; but along the banks of the stream, and within 8 miles thereof, lie about 200,000 acres of excellent land, representing $8,000,000 of possible annual crops, which would be rapidly developed if the farmers could get their goods to market with certainty and ease. The river from Little Rock to the Lumber River is well adapted to pole-boats, and from the Lumber River to the Great Pee Dee is well adapted to a service by small stern-wheel 30-ton boats such as are in use on neighboring streams, and the development of a commerce of over $400,000 may be expected as soon as the river is once properly cleared. This improvement, in connection with the existing improvement of the Great Pee Dee River, will put this river basin in immediate communication with the ocean.

The entire amount estimated as necessary for clearing the river might be advantageously expended in a single year.

I have therefore to recommend that $50,000 be appropriated in a single sum for the improvement of the Little Pee Dee River, South Carolina, by clearing it for a 4-foot draught steam navigation from its mouth upward to the Lumber River, and thence for a 4-foot draught pole-boat navigation upward to Little Rock, S. C.

Small and irregularly voted appropriations will probably greatly increase the final cost of the work.

Respectfully submitted.

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 24.

PRELIMINARY EXAMINATION OF ALLIGATOR CREEK AND OTHER WATERS CONNECTING SANTEE RIVER AND BULL'S BAY, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following report upon the examination of Alligator Creek and other waters connecting Santee River and Bull's Bay, South Carolina, provided for by river and harbor act of August 5, 1886, and assigned to me by letters from your office dated September 27 and October 28, 1886.

This report is based upon my own personal inspection of the entire locality and upon various reports which I have received from various persons living near or using these water-ways.

Alligator Creek and the water-ways between Santee River and Bull's Bay are of importance mainly as forming a portion of the water route between the Santee River and Charleston, S. C. Its local commerce is very small. There is only one small town, McClellanville, within 10 miles of the creek, and only one small parish (Saint James, Santee), which could be benefited by the improvement. The Santee River empties into the Atlantic Ocean by two principal mouths. At neither mouth is it safe for 6-foot draught steamers to go out except at high tide and calm weather, the ocean bar being at least 1 mile from land and the depth of water on the bar being only about 4 feet at low water. Vessels and steamers wishing to leave the Santee River must therefore go northward by the Santee River Canal and Winyaw Bay to Georgetown, or southward by Alligator Creek and its continuations to Charleston. The southern route as usually followed is 31 miles to Bull's Bay and 77 miles to Charleston, going from the northern or main branch of the Santee 6 miles through Six-Mile Creek; thence 2 miles down the South Santee; thence 9 miles through Alligator Creek; thence 2 miles through the Needle's Eye; thence 1 mile along Casino Bay; thence half a mile along Slack Water Reach; thence 6 miles by Cape Romain Big Creek; thence 3 miles by Bull Creek or Sett Creek to the edge of Bull's Bay; thence 1¼ miles across Palmetto Flats to deep water in Bull's Bay; thence 10 miles more across Bull's Bay; thence 36 miles further through narrow creeks or sounds and over at least five shallow reaches to Charleston. Vessels can leave this route in pleasant weather and high tides and go direct to Charleston by the ocean either from the South Santee over its 4-foot bar, or from Casino Bay over its flats and its 7-foot bar between the Horns and Cape Romain; or from Bull's Bay over the 8-foot bar.

The usual route through Casino and Bull's Bay can hardly be called an inside route since Casino Bay is a bay 1½ miles deep, 3 miles wide at its mouth, and opening direct upon the ocean, and Bull's Bay is a bay 4 miles deep, 7 miles wide at its mouth, and also opening direct upon the ocean. No vessels, flats, or rafts could pass through either bay except during calm weather and high water. The obstructions along this route are approximately as follows: At the end of Alligator Creek a mud and sand shoal of about 400 feet length and 4 feet depth at low water; in Alligator Creek, at the meeting of the waters from Santee River and Casino Bay, an oyster-rock shoal of 2,000 feet length and 3 feet average depth at low water; in Casino Bay, a mud and sand shoal (Casino Flats) of 5,000 feet length and 2 feet depth at low water; in Slack Water Reach, a mud and sand shoal of 400 feet length and 4 feet depth at low water; at Bull's Bay, a mud and sand shoal (Palmetto Flats) of 3,000 feet length and bare at dead low water. Elsewhere this route is at least 6 feet deep and 60 feet wide at low water. The dredging of this route to 100 feet width and 6 feet depth at low water might, according to the above dimensions, require about 300,000 cubic yards of dredging at a cost of about $60,000.

The shoals in Alligator Creek might be permanently removed by simple dredging, but those at Casino Flats and Palmetto Flats would probably be again formed by the next severe storms.

A cut direct through the marsh from Needle's Eye to Cape Romain Big Creek, so as to avoid Casino Bay and Slack Reach, and from Bull or Sett Creek into Long Creek or Harbor River, so as to avoid Palmetto Flats, might require about 450,000 cubic yards of dredging at a cost of about $90,000. This route or some other similar route through the marshes would probably be much more permanent than any attempted cutting through Casino and Palmetto flats. In this way it might cost as much as $90,000 to open an inland route 31 miles long, 60 to 100 feet wide and 6 feet deep, from the Santee River to Bull's Bay.

The commerce to be benefited is, as before stated, mainly that of the Santee River. Ten sail boats, of from 5 to 25 tons burden, and two steamers, of 350 to 400 tons burden (150 feet long, 50 feet wide, and 5 to 6 feet draught), make about four trips per month through this route during the greater part of the year, carrying about $500,000 of goods, either cotton, rice, naval stores, etc., out of the Santee River, or fertilizers and general merchandise up into the river. The commerce of the Santee River must continually increase, especially as the river is now already cleared up to Camden, on the Wateree, and is being cleared up to Columbia, on the Congaree. The commerce of this river will soon reach such a magnitude that it is very important it should have a free outlet by an inland route both to Charleston and Georgetown. The route to Georgetown is already partially opened and that to Charleston is, in my opinion, equally necessary. The local traffic along Alligator Creek to Bull's Bay is small and restricted to that of McClellanville and the rest of Saint James Parish, Santee.

This parish (according to the 1880 census reports) possesses 3,744 total population and produces annually about $60,000 (mainly cotton and rice) of farm crops. One thousand dollars spent in the removal of a small oyster-rock barricade at the mouth of McClellanville Creek, 1 mile from town, would allow boats of 8 feet draught to go up to within 300 feet of the existing wharves of McClellanville; and this improvement would probably add at once at least $20,000 to the annual commerce of the Saint James Parsh, Santee. For this reason, I am of the opinion that such improvement of McClellanville Creek is a worthy improvement and should be included in the general improvement of the waters connecting Santee River and Bull's Bay or Charleston.

In my opinion the interests of the commerce of Saint James Parish, Santee, and that of the commerce between the Santee River and Charleston, render Alligator Creek and other waters connecting Santee River and Bull's Bay worthy of improvement by the General Government.

The exact location and cost of this improvement can only be determined by a special survey. As the best route can only be determined after a special examination of about 40 square miles of marsh and a survey of about 30 miles of creek and 2 square miles of ocean bay, this survey will take a good deal of time and can not be completed early enough for me to make any final report to the present Congress. The cost of this survey is estimated at $1,500.

At the same time that I regard this route as worthy of improvement, I am inclined to believe that it is not the one most worthy of improvement between the Santee River and Charleston. As before stated, no steamers, boats, nor rafts can safely pass through Bull's Bay at present in rough weather and low water, and there is no good reason for expecting that any permanent channel across Bull's Bay can be obtained at any reasonable cost.

From various sources of information, which I believe to be reliable, there is, however, good reason to suppose that a permanent inland route can be obtained, at a reasonable cost, from the Santee River to Charleston through Alligator Creek, Owendaw Creek, and Wandoo River and the connecting marshes or swamps so as to pass entirely in rear of Casino Bay and Bull's Bay. If such a route be practicable its

doption would obviate the necessity of the expensive and doubtful
ork which might otherwise have to be done at Bull's Bay, and would
ive results far more advantageous to commerce.

* * * * * * *

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers, approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

URVEY OF ALLIGATOR RIVER AND OTHER WATERS CONNECTING SANTEE RIVER AND BULL'S BAY, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., September 5, 1887.

GENERAL: In accordance with instructions from your office, dated
arch 16, 1887, and the river and harbor act of August 5, 1886, I have
erewith to submit my report upon the survey of Alligator River and
ther waters connecting Santee River and Bull's Bay, with a project
r its improvement and an estimate of such improvement.

This project and estimate of cost are based upon a survey of the por-
on needing improvement as made by Assistant Engineer Reid Whit-
rd, and as checked and completed by United States Coast and Geodetic
urvey maps of 1874, and as checked by an inspection of the whole route
ade by myself in sail or row boat. This route, tidal throughout its
tire length, is at present in use by steamers and sail-boats passing
om the Santee River to Charleston; but it is badly obstructed at low
ater, mainly by one oyster-rock shoal and four mud and sand shoals.
therwise it possesses everywhere at least 100 feet width and 6 feet
epth of channel at low water. The route can be improved by dredg-
g at two of the shoals and by avoiding the other three shoals by the aid
f canal cuttings through the neighboring marsh. In my opinion these
redged channels, if cut to 100 feet width, will remain tolerably per-
anent for many years. The characteristic features of the route and
cality are fully developed in my report of February 4, 1887, on its
reliminary examination; and the further nature, extent, and location
f the proposed channel and estimate of its cost are fully shown in the
port of the assistant engineer and in the maps herewith forwarded.
r. Whitford deserves much credit for his efficient prosecution of the
rvey, especially in view of the limited funds at his disposal. The pro-
sed route is indicated on the inclosed maps by the numbers 1 to 17,
om Santee to Bull's Bay, and by numbers 13, 18, 19, 20, to McClellan-
lle.

In my report of February 4, 1887, I stated that this route was of
portance mainly as forming a portion of the water route connecting
e Santee River with Charleston, S. C.; that I was of the opinion that

the best route between these places would be one not entering B Bay at all; and that it would be advantageous to have this examina and survey so modified by Congress as to cover the connection of Sa River with Charleston instead of with Bull's Bay. Cut No. 3 of herewith proposed route, while allowing an entrance into Bull's Ba so located as to avoid the objectionable features of such an entra and is also so located as to form part of a future route to Charle along the line (suggested in my report of February 4, 1887) thro Owendaw Creek, marsh, canals, and Wando River, should such a r be requested by Congress.

The commerce of this route (shown in detail in the report of the as ant engineer) is stated to be at present about $1,000,000, with a prob increase to $2,000,000 within a few years. While I am of the pers opinion that the present commerce is slightly overestimated, I equally confident that the probable future commerce is, if anyth underestimated; and believe that the improvement of this route, if menced at once, will scarcely be completed in time to accommodat growing commerce. For these reasons I believe it advantageous t Government to assist in the completion of a 6-foot draught channel a this route to McClellanville and Bull's Bay. The completed chann 6 feet depth and 100 feet width (for details, see report of assistan gineer) will cost about as follows:

Dredging	$15
Superintendence and contingencies, 20 per cent	3
	18

The entire amount estimated might be advantageously expend a single year.

I have therefore to recommend that $183,000 be appropriated single sum for the improvement of Alligator River and other w connecting Santee River and Bull's Bay by dredging through shoal cutting across intervening marshes, so as to establish a 6-foot dra free navigation from the Santee River to Bull's Bay, and to the to McClellanville.

Small and irregularly voted appropriations will greatly increa final cost of the work.

Respectfully submitted,

W. H. BIXBY,
Captain of Engine

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

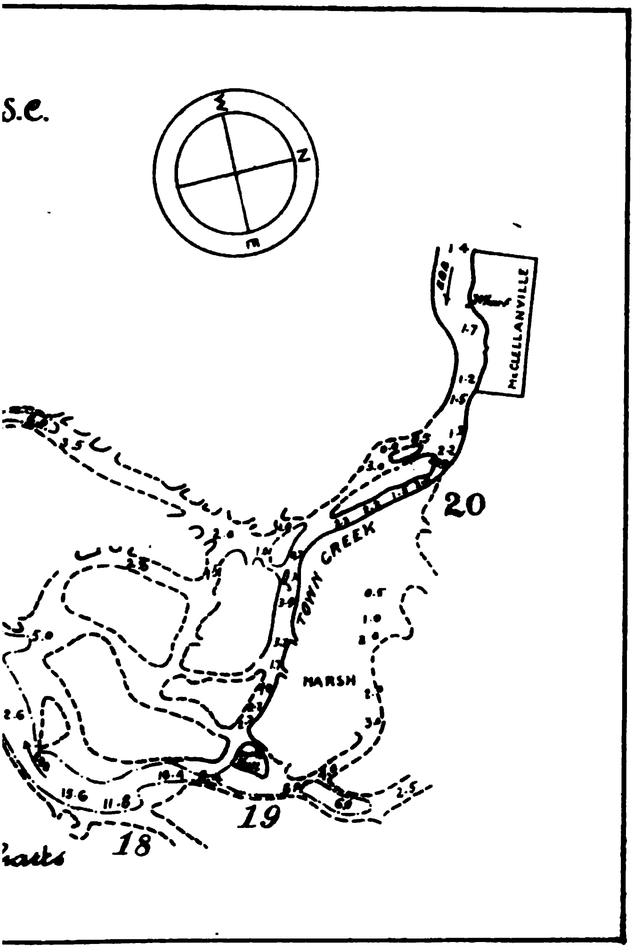
UNITED STATES ENGINEER OFFIC
Georgetown, S. C., June 10,

CAPTAIN: In compliance with orders and detailed instructions contained i letter of April 9, I have the honor to make the following final report upon t vey of Alligator River and other waters connecting Santee River and Bull South Carolina.

The party left Georgetown for Cape Romain in a sailing schooner on the 6th May, 1887, and arrived at their destination on the 8th; the field-work began 9th and ended on the 24th. They returned to Georgetown on the 25th.

The Santee mouth of Alligator River was selected as the initial point of t vey, and was continued thence by compass bearings and stadia measurement tances and location of sounding stations were obtained in the following manne transit was set along on the marsh land, and numbered tags, attached to g

S.C.
hacks


S.e.
N
MCCLELLANVILLE
Wharf
1.4
1.7
1.2
1.5
2.2
3.0
2.5
2.0
TOWN CREEK
20
0.5
1.0
2.0
MARSH
3.4
5.0
2.6
19.6
11.8
10.4
6.0
2.5
19
18
harts

cane, were located as far each way as the stadia rod could be read, the last tag at which the rod could be seen being moved up to by the transit.

When the map was being made on a scale of 100 feet to the inch, these tags were put up generally every 100 feet, but only located by the transit every 200 feet, the intermediate ones being taken as one-half way between the numbers regularly located.

The width of the stream was taken from time to time by having the man putting up the tags to row across to the opposite shore and give the transit man a sight at the rod. Where the scale being used was smaller than 100 feet to the inch, these sounding-station tags were put up at greater intervals.

The transit notes were plotted in the field on cross-section paper as fast as taken. Many soundings were taken from shore to shore; these being more numerous where the scale was large, and their location being fixed by the numbered tags attached to the canes. These soundings were reduced to a local low water determined by one tide in the vicinity of the work. The zero of the gauge was set at this low water, and was not moved so long as the difference in time of tides was not seriously affected by the distance of the work from the gauge. When this difference amounted to enough to cause incorrect soundings, the gauge was moved up, and the same plan pursued again. This system was carried throughout the whole survey.

Bench-marks were fixed at each gauge, securing the elevation of the zero of each. More especial care was taken with the survey of points where dredging would be required. These points are indicated by the scale of the maps being larger than 1,000 feet to the inch, except the lengths of the lines of the proposed cut-offs, which are measured from deep water to deep water.

Information in detail as to location of gauges and bench-marks, with their elevations, what soundings refer to each gauge and bench-mark as per detailed maps, what scales were used on the maps in each portion of the survey, is shown on a consolidated map *

Our survey was continuous from Santee River to Bull's Bay. The result of the entire work is shown on fourteen sheets of original rough field-maps, which are respectfully sent herewith.*

The object of the survey was to determine the practicability and cost of completing an inland water route between the Santee River and Bull's Bay, and from Romain River to McClellanville, S. C., of 100 feet width and 4, 6, and 8 feet depth at low water.

It is thought that any dredged channel between Santee River and Bull's Bay would have a tendency to fill more or less in time, requiring occasional dredging. It is also believed that the route via numbers 1, 25, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, would probably remain more permanently open than by any other line so far examined. This would be because of its comparative freedom from cross-currents and its protection from damaging winds, as well as possibly avoiding meeting points of tides in the improved channels. Aside from this, it possesses the marked advantage of being an inside passage, and, consequently, there will be no interruption of traffic in stormy weather.

For these reasons it is respectfully recommended that this route be preferably selected as the one to be improved. Should the dredging be done from No. 6 (see sheet 14), via Casino Bay and Slack Reach, numbers 23, 22, and 21, it is believed that the channel thus improved would not remain permanent, because being exposed to easterly winds blowing across the line of work, and the consequent shifting of currents, would soon lessen the depth of the channel excavated. This route would also be subject to filling from another cause, namely, by the sediment discharged from the mouths of the Santee and Alligator rivers being swept down to and deposited in the dredged channel during the prevalence of northeasterly and easterly winds, which at times blow with great violence along this section of the beach (coast). Besides, traffic would necessarily be considerably delayed in stormy weather by the exposed condition of Casino Bay, which fronts the ocean.

During the writer's presence in this survey, he had occasion to watch the effect of two easterly and northeasterly gales of wind on Casino Bay. The waves rolled in across the bay in a manner which appeared to be at right angles with almost any channel which could be selected from there through Slack Reach into Romain River. It is believed that either of these gales would have considerably damaged any dredged channel existing.

Should the line of dredging be carried up Congaree Boat Creek, thence through the lower parts of Mud and Oyster bays, it is believed that the dredging in the bays would not remain open, unless long lines of expensive training-walls were built to contract the water to a given width and guide the currents in fixed directions. The currents flow in and out of these bays in nearly every direction, and as they enter from the various creeks and sloughs they sluggishly spread all over the bays, covering a comparatively large area of ground with very little water, depositing by the meeting and slacking of the currents whatever sediment they may have brought up. In going out they fork and run in many directions, and not with sufficient force to scour up and carry back the deposits which may have been made on the flood.

---

* Omitted, and a reduced map in three sheets substituted.

There is plenty of water, after getting into Bass Bank Creek, all the way through Romain and Bull rivers to the mouth of the latter. Here the river is connected with Bull's Bay by what is known as Palmetto Flats. The shoal water begins immediately at the mouth of Bull River and extends thence for at least a mile, the average depth being not over 1 foot at low water, in every direction to the channel in Bull's Bay. The bottom of Palmetto Flats consists of soft mud and sand.

It is thought that the result of any attempt to provide a dredged channel from the deep water in the mouth of Bull River, through Palmetto Flats to the Bull's Bay Channel, would in no way prove satisfactory. The length to be dredged here would be long, the width and depth considerable, and the whole work would no doubt be expensive. After once excavated, it would probably not remain as desired unless miles of training-walls were constructed of stone or creosoted wood, along the dredged channel, with its top equal at least in height to the high-water level. There is no especial advantage to be derived, so far as known, by carrying the improvement into Bull's Bay through Palmetto Flats.

There is a much better route, it is believed, found by leaving the deep water in Bull River at 14 (see sheet 14), and cutting through the marsh land to deep water in Long Creek, thence past the mouth of Harbor Creek into the Bull's Bay Channel.

The distance to be cut through the marsh land from creek to creek is not long. It is thought that this route is in every way preferable to the Palmetto Flats route. The large volume of water which would of necessity be forced in and out of this cut on both ebb and flood tides would doubtless prevent any filling.

The route examined to the town of McClellanville, via McClellanville and Town creeks, has sufficient water up to the mouth of the latter creek, within less than a mile of the town itself. At the mouth the water shoals suddenly, and continues very shallow up to the town. It is thought that this route is as good as any other in this direction, and possesses the advantage of being along the frontage of the town where commerce is carried on.

The shallowness of Town Creek is no doubt caused by the numerous sloughs running into it, through the low marsh lands, which has, by long continued washing in, choked the creek up to its present condition. It will be necessary to extend the dredging from the mouth of the creek continuously to the town, and it is thought that if the excavated material be thrown to the right and left, forming mud and shell dikes across the mouths of the above-mentioned creeks, that the dredged channel would probably remain permanently open.

DESCRIPTION OF THE LINE AND CHARACTERISTICS OF THE MATERIAL ALONG IT AS RECOMMENDED TO BE IMPROVED.

The shoal at the Santee mouth of Alligator River is composed of soft mud. The bottom through Alligator River to Tide Gauge Creek is of soft mud, with an occasional indication of sand and shells. The shoal from Tide Gauge Creek to Price Island is composed of shells and mud; from Price's Island, through Ram Horn and Needles Creek to Mill Creek, the bottom is soft mud.

There is no work needed from Mill Creek to the first cut-off at 7, via Mill, Casino, and Congaree Boat creeks. The soil of the proposed cut-off 7 to 8 is probably soft mud and shells. There is no work needed from 8 to 9. From 9 to 10, another proposed cut-off, the soil is probably the same as from 7 to 8. There is no work needed from 10 to 14 for 6 feet depth. The soil from 14 to 15, another proposed cut-off, is probably composed of soft mud, shells, and sand. There is probably very little, if any, work needed from 15 to 17 for 6-foot depth. From 13 to 19 there is no work needed; from 19 to 20 the bottom is composed of mud and shells.

The marsh lands through which the proposed cut-offs pass doubtless have sufficient firmness of foundation to support the excavated material which may be thrown out, without caving to much extent.

The following estimates of quantities to be excavated and cost are based upon 100 feet width of channel, and 4, 6, and 8 feet depth of water in same at low tide, following the line from Santee to Bull's Bay, as recommended.

ESTIMATE NO. 1.—*Width of channel 100 feet, and 4 feet depth at low water.*

Locality.	Number cubic yards.	Material.	Price per yard.	Amount.
			Cents.	
At Santee, mouth of Alligator River	400	Soft mud	25	$100.00
From Santee, mouth of Alligator River, to upper mouth of Tide Gauge Creek:				
From upper to lower mouth of Tide Gauge Creek	2,000	Shells and mud	25	500.00
From lower mouth of Tide Gauge Creek to Needles Creek	4,000	......do	25	1,000.00
Through Needles and Mill creeks to Casino Creek, as follows:				
Deepening present width of water in Needles Creek	14,074	Soft mud	25	3,518.50
Widening Needles Creek 50 feet additional by removing marsh land	53,000	Mud	25	13,250.00
From Mill Creek, mouth of Needles Creek, through Mill Creek to Casino Creek	1,851	......do	25	462.75
From Casino Creek, mouth of Mill Creek, via Casino and Congaree Boat creeks, to No. 7.				
No. 7 to No. 8, cut No. 1, through the marsh land.	85,000	Mud and shells	25	21,250.00
No. 9 to No. 10, cut No. 2, through the marsh land.	111,759	......do	25	27,939.75
From No. 10 to No. 14, via 10, 12, and 13	....	....	....	....
From 14 to 15, cut No. 3	85,000	Mud, sand, and shells	25	21,250.00
To McClellanville, via Romain River, McClellanville and Town creeks, as follows:				
McClellanville Creek to mouth Town Creek.	....	....	....	....
Mouth of Town Creek to McClellanville	40,000	Soft mud and shells	25	10,000.00
Total	397,084	....	....	99,271.00

ESTIMATE NO. 2.—*Width of channel 100 feet; depth, 6 feet at low water.*

Locality.	Number cubic yards.	Material.	Price per yard.	Amount.
From 6-foot curve in Santee River, through Alligator River, to Shell Shoal at upper mouth Tide Gauge Creek	108,995	Sand and soft mud	25	$27,248.75
Shell shoal at upper mouth Tide Gauge Creek between stations 362 and 366)	4,444	Shells and mud	25	1,111.00
From station 366 to north end of Price Island	3,111	......do	25	777.75
From north end of Price Island, between that and John's Islands and the west shore to Ram Horn Creek	10,096	Soft mud	25	2,524.00
Ram Horn Creek to mouth of Needles Creek	866	......do	25	216.50
Needles Creek, deepening the present width of the creek	24,629	......do	25	6,157.25
Widening the present width of creek 50 feet additional; solid cutting in the marsh land	70,000	Soft mud and sand	25	17,500.00
Mill Creek from Needles to Casino Creek	15,111	Soft mud	25	3,777.75
From Mill Creek to 7, via Casino and Boat creeks	....	....	....	....
From 7 to 8 (cut-off No. 1), solid cutting through marsh land	105,000	Soft mud and shells	25	26,250.00
From 8 to 9	....	....	....	....
From 9 to 10 (cut-off No. 2), solid cutting through the marsh land	138,055	......do	25	34,513.75
From 10 to 14	....	....	....	....
From 14 to 15 (cut-off No. 3), solid cutting through the marsh land	89,074	Sand, mud, and shells	25	22,268.50
From 15 to 16, in Long Creek	....	....	....	....
From 16 to 17	1,333	Sand and shells	25	333.25
McClellanville Creek to mouth of Town Creek	....	....	....	....
Town Creek to McClellanville	40,000	Mud and shells	25	10,000.00
Total	580,714	....	....	152,678.50

ESTIMATE No. 3.—*Width* 100 *feet, and depth* 8 *feet at low water.*

Locality.	Number cubic yards.	Material.	Price per yard.	Amount.
From 8-foot curve in Santee River, through Alligator River, to north end of Price's Island	287, 963	Soft mud, shells, and sand.	25	$71, 990. 75
From north end of Price's Island to Ram Horn Creek	15, 716	Soft mud	25	3, 929. 00
In Ram Horn to Needles Creek	7, 000	do	25	1, 750. 00
In Needles Creek to Mill Creek	122, 037	do	25	30, 509. 25
In Mill Creek from Needles to Casino	27, 703	do	25	6, 925. 75
From mouth of Mill Creek to 7, via Casino and Congaree Boat creeks	....	....	....	....
From 7 to 8 (cuts-off No. 1)	125, 000	Soft mud and shells	25	31, 250. 00
From 8 to 9	....	....	....	....
From 9 to 10 (cut-off No. 2)	164, 352	Soft mud and shells	25	41, 088. 00
10 to 14, shoal at Mouth of Duck Creek in Romain River	1, 852	Soft mud	25	463. 00
14 to 15 (cut-off No. 3)	111, 111	Mud, sand, and shells	25	27, 777. 75
16 to 17, at mouth of Long Creek	2, 814	Sand and shells	25	703. 50
In McClellanville Creek to Town Creek	....	....	....	....
In Town Creek to McClellanville	93, 333	Mud and shells	25	23, 333. 25
Total	958, 881	....	....	239, 720. 25

COMMERCE.

McClellanville, the only town in this vicinity, is situated on the mainland, about 9 miles in a northwesterly direction from Cape Romain light-house, and about 36 miles by land from Charleston. Its population amounts to about 600. They have a tri-weekly mail to and from Charleston, being carried in vehicles drawn by horses. The traffic of the town is carried on by small sailing vessels exclusively, to and from Charleston.

The want of sufficient water to the town prevents the establishment of a line of small steamers there. The people in this vicinity are sadly in need of some quicker means of transportation than they now have. The difficulty in this way does not permit the fertile lands in that section to be developed as they should, nor allow the commerce to grow, as it no doubt would with better and quicker facilities for transportation.

The fish, oyster, and game interest would, under these circumstances, no doubt, soon become of marked value.

From the best authorities to be found the following figures on the yearly commerce have been collected:

THE TOWN OF M'CLELLANVILLE.

Articles.	Quantity.	Amount.
EXPORTS.		
Cotton .... bales	1, 500	$60, 000
Naval stores .... barrels	9, 000	12, 000
Rice (rough) .... bushels	100, 000	100, 000
Miscellaneous freights	....	20, 000
IMPORTS.		
General merchandise	....	150, 000
Total	....	342, 000

The above figures were furnished by Mr. W. B. McClellan, of McClellanville, who thinks that if there was more depth of water to the town the above figures would soon be doubled.

LOCAL COMMERCE IN BULL'S BAY.

The cultivation of oysters is carried on to quite an extent in this bay, and it is rapidly growing into a valuable enterprise. The "Bull's Bay Oyster Company" has so far planted about 10,000 bushels of oysters, and it is expected to have planted this ason an additional 40,000 bushels. The capital of the company amouts to $20,000, nd it is intended to increase it within a year to $100,000.

The value of the present year exports by this company from Bull's Bay amounts o—

Oysters	$15,000
Fish and game	5,000
Total	20,000

The foregoing information was furnished by Mr. Samuel J. Pregnall, a large stock-lder in the Bull's Bay Oyster Company, and R. Magwood, superintendent of the me company.

OMMERCE FOR THE PAST YEAR BETWEEN SANTEE RIVER AND CHARLESTON, VIA ALLIGATOR RIVER AND OTHER WATERS CONNECTING SANTEE RIVER AND BULL'S BAY, SOUTH CAROLINA.

The commerce was carried on by two side-wheel steamers, the tonnage of each being 0.

Articles.	Quantity.	Value.
IMPORTS.		
tton .... bales..	7,657	$343,565
sin .... barrels..	13,893	41,679
irits turpentine .... casks..	3,432	68,640
k staves .... number..	20,123	12,600
her freights .... packages..	8,093	29,246
Total	....	495,730
EXPORTS.		
eral merchandise .... tons..	3,455	236,122
Total	....	731,852

This information was furnished by Mr. W. P. Holmes, agent of South Carolina teamboat Company.

This company own and run the steamboats between Santee and Bull's Bay, above ferred to.

Mr. Holmes goes on to say in his letter that when the Wateree and Congaree vers are open to navigation the business of the steamers would be more than oubled at once.

From the above the annual total commerce carried over the route between Santee d Bull's Bay amounts in value to $1,093,852. It is thought that the above-referred- route is worthy of improvement, because of its present considerable commerce, d because of an increase to commerce, which would likely follow improvement.

It is, therefore, respectfully recommended that you consider the advisability of rming a project for the improvement of some inland water-route between Santee ver and Bull's Bay, South Carolina.

In handing you the maps of the survey it is respectfully asked that you consider e restricted funds and time with which it was necessary to do the work, and there- re make allowance for any defects you may find in them.

The soundings were recorded in the field by the undersigned, and he in person ex- mined as carefully as time permitted all the routes mentioned above.

It is believed that the result of the survey is sufficiently accurate upon which to se estimates for projects looking to an improvement of the inside passage between ntee River and Bull's Bay, South Carolina.

Mr. H. F. Price, surveyor, and other members of the party have my thanks for the heerful and faithful performance of their duties.

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

APPENDIX N.

IMPROVEMENT OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA AND GEORGIA, AND PART OF THE ATLANTIC COAST OF FLORIDA.

REPORT OF COLONEL Q. A. GILLMORE, CORPS OF ENGINEERS, BVT. MAJ. GEN. U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Charleston Harbor, South Carolina.
2. Wappoo Cut, South Carolina.
3. Ashley River, South Carolina.
4. Edisto River, South Carolina.
5. Salkahatchie River, South Carolina.
6. Savannah Harbor and River, Georgia.
7. Savannah River, Georgia.
8. Savannah River, above Augusta, Georgia.
9. Saint Augustine Creek (Thunderbolt River), Georgia.
10. Romerly Marsh, Georgia.
11. Altamaha River, Georgia.
12. Doboy Bar, Georgia.
13. Brunswick Harbor, Georgia.
14. Entrance to Cumberland Sound, Georgia and Florida.
15. Inside Passage between Fernandina and Saint John's River, Florida.

EXAMINATION.

16. From Doboy Island to Doboy Bay, Georgia.

UNITED STATES ENGINEER OFFICE,
New York, July 30, 1887.

SIR: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ended June 30, 1887.

* * * * * * *

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

N 1.

IMPROVEMENT OF THE HARBOR AT CHARLESTON, INCLUDING SULLIVAN'S ISLAND, SOUTH CAROLINA.

During the fiscal year ending June 30, 1887, operations for improving the entrance into Charleston Harbor, South Carolina, were carried on in conformity to the plan submitted in my communication to the Chief of Engineers dated March 9, 1878, and printed as Appendix H of the Annual Report of the Chief of Engineers, 1878.

By this project it is designed to establish and maintain, by means of two jetties, a low-water channel of not less than 21 feet depth across the bar, upon which the greatest available depth has heretofore been only 11½ feet. The estimated cost of the project is $3,000,000.

Previous to the spring of 1878 there had been expended by the General Government in the improvement of the ship-channels in Charleston Harbor, subsequent to the close of the civil war (from 1871 to 1878), the sum of $93,700 in taking up the wrecks of fourteen iron-clad and wooden vessels sunk during the war, and in removing a portion of the Bowman Jetty projecting into Beach Channel.

RECAPITULATION OF OPERATIONS PREVIOUS TO JUNE 30, 1886.

North Jetty.—This work was commenced in December, 1878. The bottom course of the jetty now reaches a point 14,327 feet from the shore end on Sullivan's Island, measured along the axis of the work. The widths of the log mattresses of the course vary from 43 feet on the shore to 118 feet at the sea end; the height, including riprap stone, from 2½ to 4 feet. A second course of mattresses and stone was laid over certain portions of the foundation course, to wit, for a length of 1,648 feet, from a point 7,600 feet seaward from the shore end, using mattresses from 66 to 81 feet wide, and for a length of 2,030 feet seaward from a point about 11,090 feet from shore, with mattresses 55 feet in width. Southeast of Drunken Dick Shoal, from a point about 7,200 feet from shore to within about 560 feet of the seaward end of the jetty, additional stone has been distributed over it. The mattresses used in the north jetty amounted to 156,078 square yards, and 101,495 cubic yards of riprap stone were placed on top.

South Jetty.—This work was commenced in April, 1880. On June 30, 1886, the seaward end of the foundation course had reached a point 16,440 feet from the shore end on Morris Island, measured along the axis of the work. This course is formed of log-and-brush mattresses averaging 18 inches in thickness, overlaid with riprap stone to a depth of from 12 to 14 inches. The width of the mattresses varies from 40 to 130 feet, but at the crossing of the existing main ship-channel the width of the bottom course has been increased for a length of 1,570 feet by adding an apron of mattresses and stone; the total width of the course varies here between 135 and 206 feet. A second course of mattresses and riprap stone, similar to the first, with widths varying from 40 to 55 feet, and of an aggregrate length of 10,586 feet, was laid in four detached sections upon the lower course; and a third course of mattresses, 44 feet wide, was placed upon the second course for a length of 1,206 feet where the jetty crosses the deep pocket east of the main ship-channel. Additional stone was deposited in the form of a ridge along the center line of the jetty between points situated 7,986 feet and 14,025 feet, respectively, from the shore end. The material used in the south jetty amounted to 287,038 square yards of mattresses and 124,147 cubic yards of riprap stone.

Dredging.—Some dredging was done on the bar between the parallel seaward portions of the jetties between July 1 and December 31, 1886. The material removed consisted of sand and broken shells, and amounted in the aggregate to 85,549 cubic yards. The operations were too limited in extent to produce any marked effects.

Sullivan's Island.—Two spur-dikes have been constructed here with a iew of protecting the south shore of the island from the encroachment f the sea. One of these dikes was built in 1880, the other in 1881.

Mount Pleasant.—This place is situated in the bight formed by Hog sland Channel, 3 miles from the city of Charleston. Two spur-dikes ere built in 1884, forming part of a plan devised to prevent the wash- ng away of the shore-line, which had been progressing for several years. he plan forms no part of the existing project for improving the en- rance to Charleston Harbor.

Details of the foregoing operations are included in my annual report r the year 1886.

Field work.—A large amount of field work has been performed in con- ection with the work of construction. Special examinations, including orings and current observations for locating the jetties, were required, nd since 1881 six, more or less, extensive hydrographic surveys of the uter harbor and bar and one entire survey of the inner harbor have een made. A system of triangulation adopted several years ago has erved as a basis for these and future surveys.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

No dredging was done in the past fiscal year.

The work of raising the height of both jetties at various points has een continued under a contract made with Mr. Anson M. Bangs. The aterials and mode of construction employed have been substantially he same as under previous contracts.

The river and harbor bill passed by the Forty-ninth Congress at its st session having failed to become a law, and a suspension of opera- ions for an indefinite time after the existing appropriation is exhausted eeming to be inevitable, it is proposed to reserve a sum of from $25,000 o $30,000 to be used in repairing any damages which may occur to the etties while work is suspended, applying the balance of the available unds in raising and strengthening both jetties.

Operations on the jetties, which were last suspended in January, 1886, ere resumed in December, and were still in progress at the close of the scal year.

South Jetty.—The first work done under the present contract consisted n laying an apron of mattresses covered with riprap stone on the south ide of the jetty where it crosses the deep pocket east of the main ship- hannel. This apron is a seaward continuation of a similar work pre- iously laid, and extends from a point about 6,900 feet from the present hore end 2,686 feet seaward. On that length a trench had formed be- yond the ends of the logs of the bottom course formerly laid, due to the verpour of the strong currents of the ebb tide, the further development f which was liable to compromise the stability of this section of the South Jetty. The mattresses used in the new apron were 60 feet wide, nd to that extent nearly the original bottom course, which varied on this reach from 108 to 130 feet in width, was accordingly enlarged. The attresses received a covering of stone averaging 18 inches in thick- ess.

To reduce the volume of water which at ebb tide was being deflected cross the low crest of the jetty at this point, and to divert it toward the crest of the bar between the jetties, the work was here raised for a length of 601 feet, beginning at a point about 7,730 feet from the present shore end. Riprap stone was distributed over the middle 30 feet, using 4½ cubic yards of stone per linear foot. To strengthen and preserve the advanced portions of the South Jetty, located in shallo water and exposed to violent breakers, stone was deposited upon th middle 36 feet of the work, commencing at a point about 14,000 fee from the present shore end. At the close of the fiscal year 207 linea feet had been thus re-enforced, employing 2⅝ cubic yards of stone pe linear foot.

North Jetty.—The central portion of the jetty, located on Drunke Dick Shoal, having settled at some places, an additional course was lai over the old foundation, extending 2,136 feet seaward from a point abou 5,300 feet from the shore end. Mattresses 90 feet in width covere with a layer of broken stone averaging 18 inches in thickness wer used. Subsequently 3,300 cubic yards of stone was distributed ove the middle 20 feet of this course, to secure additional strength and level off the rather irregular surface.

Nineteen thousand and seventy-seven square yards of mattresses and 13,227 cubic yards of stone were used in the work on the North Jetty, and 18,621 yards of mattresses and 9,508 cubic yards of stone on the South Jetty during the fiscal year. The material used from the beginning of operations to June 30, 1887, aggregated 480,814 square yards of mattresses and 250,959 cubic yards of stone, the latter equivalent in weight to about 313,700 gross tons.

LENGTHS OF THE SEVERAL COURSES LAID FROM BEGINNING OF OPERATIONS TO JUNE 30, 1887.

	Feet.
North Jetty:	
Length of bottom course from shore end on Sullivan's Island	14,327
Length of second course, mattresses and stone	5,814
South Jetty:	
Length of bottom course from present shore end on Morris Island	16,440
Length of second course, mattresses and stone	10,586
Length of third course, mattresses and stone	1,206

The sea end of the North Jetty is 925 feet from the outer 18-foot curve, and that of the South Jetty 2,250 from the same, both distances being measured along the prolongations of the axes of the jetties.

CONDITION AND EFFECTS OF THE WORKS, AND CHANGES IN THE HARBOR AND ON THE BAR.

The jetties.—No material changes in the condition of either jetty have occurred during the past fiscal year, except such as are due to the work done in that period. On June 30, 1887, the crest of the new riprap stone filling over that part of the North Jetty which crosses Drunken Dick Shoal reached nearly up to the level of mean low water. A year before the low-water depth over the work at this place varied from 7 to 12 feet.

The South Jetty has been somewhat damaged at the point where its foundation course rises above the low-water line on the beach of Morris Island, a section of about 50 feet in length having apparently gone out. For a similar length between high and low water mark the work has settled to some extent. A considerable quantity of riprap stone has been washed off the shore-end portion of the jetty, and desposited on the beach, a short distance to the north of it. Early repairs are needed here. The apron laid during the year for protecting the base of the work where it crosses the deep pocket is of too recent construction to enable me to say whether the threatening scour has been effectually stopped thereby. The crest of the stone filling on top of the jetty at the same place, lately commenced, is at present very irregular, but will be leveled off as far as practicable under the existing contract. At the seaward end of the jetty, the work of raising and strengthening it with stone was only commenced in June; the crest is at the level of low water for a few hundred feet.

Swash Channel and the Bar.—No important changes have occurred in Swash Channel, or the channel between the seaward portions of the jetties, which fact may be accounted for readily, when it is considered that operations were only resumed in December last, and that from that time to and including the month of May they were limited substantially to works of protection, such as widening the foundation of the South Jetty at the deep pocket, and constructing an additional foundation for that section of the North Jetty situated on Drunken Dick Shoal. That portion of the work which may reasonably be expected to have a direct influence upon the development of the new channel could not be resumed until the last month of the fiscal year.

Jim Evans' Shoal, as defined by the 9-foot low-water curve, is somewhat smaller in area than last year, and has again moved slightly seaward. It appears this year divided in four smaller shoals, the southerly edges of which are located about midway between the jetties.

Swash Reef, with its base on the channel edge of the South Jetty near its outer end, has changed only in so far that its head or easterly end has advanced a short distance seaward.

The 12-foot low-water curve of the outer slope of the bar between the jetties has pushed out about 150 feet; the 15-foot curve also, but in a lesser degree, while the 18-foot curve has remained practically stationary. Traces of the cut dredged between the jetties in 1885 are indicated by somewhat greater depths found on its range than were shown by former surveys. No navigable channel for deep-draught vessels can be said to exist as yet between the outer portions of the works, as some lumps of less than 9-feet depth at mean low water still form obstructions.

The 18-foot low-water curve of the "Inner Pocket," to the north of the South Jetty on the inner slope of the bar is in about the same position as last year. Its seaward or easterly end is about 2,080 yards back of the present seaward end of the south jetty, and about 2,770 yards from the outer 18-foot curve. The 15-foot and 12-foot curves of the pocket have advanced seaward; the 12-foot curves of the inner and outer slopes of the bar where they approach each other are about 450 yards apart.

Drunken Dick Shoal has moved westward; its 9-foot curve nearly reaches the head of Bowman's Jetty on Sullivan's Island. The westerly entrance to the old Beach Channel is thereby practically closed.

No survey has been made recently of Pumpkin Hill Channel and South Channel, and I have no direct information concerning their present condition.

Sullivan's Island.—The high-water line near the shore end of the North Jetty, and for some 2,000 feet east of it, has remained about stationary. Between the North Jetty and Bowman's Jetty near, Fort Moultrie, the shore line has generally advanced. The two spur-jetties built on this beach for protecting the beach, in 1880 and 1881, respectively, are well covered with sand. West of Bowman's Jetty the beach has cut away about 200 feet, exposing to view the palmetto grillage or foundation of the work.

Morris Island.—The high-water line of Cummings' Point, the northern end of Morris Island, was in January, 1887, about 3,000 feet from the shore end of the south jetty, a recession southward of about 250 feet since 1884. Between Cummings' Point and a point about 900 feet north of the jetty much washing of the beach has taken place; since 1884 the shore-line has here receded over 300 feet. In the vicinity of the jetty no material changes with regard to the position of the high and low water lines have been observed; but about 2,000 feet south the cutting of the shore has amounted to about 180 feet.

Inner Harbor.—A survey made 1887 shows that the inner end of westerly entrance of Hog Island Channel, between Hog Island and Shute's Folly Island, has been still further enlarged; about 100 feet has been cut away from the southwest point of Hog Island since 1884. Further to the eastward the widening is still more marked. The available depth throughout the channel is at present 12 feet. The two spur-jetties built in 1884 for protecting the shore-line of Mount Pleasant are in fair condition. The high-water line from Shem Creek, three-fourths of a mile northwest of the ferry company's wharf, to a point about half a mile south of the wharf was recently surveyed. The shore-line was found to have receded at some places and advanced at others, the filling slightly preponderating, perhaps, since the survey of 1881. It is desirable that a special appropriation should be made by Congress for the construction of some works for contracting the inner entrance of Hog Island Channel, or at least preventing its further enlargement. In previous annual reports I have pointed out the danger of a deterioration of the deep-water area in front of the wharves of the city of Charleston, if the enlargment of this channel entrance is permitted to make further progress.

THE COMMERCE OF CHARLESTON.

For the purpose of indicating to some extent the commercial interests involved and which will be benefited by this improvement, a few statistics are appended. For comparison the records of the year 1878, when the work was commenced, and those of 1886 have been selected.

Arrivals and clearances of vessels in 1878 *and* 1836, *respectively.*

ARRIVED.

	1878.		1886.	
	Vessels.	Tonnage.	Vessels.	Tonnage.
Coastwise	396	322, 527	901	550, 20
Foreign ports:				
American vessels	44	19, 935	20	3, 714
Foreign vessels	329	163, 368	182	114, 507
Total	769	505, 830	1, 103	668, 430

CLEARED.

	1878.		1886.	
	Vessels.	Tonnage.	Vessels.	Tonnage.
Coastwise	266	172, 988	890	543, 259
Foreign ports:				
American vessels	45	24, 397	25	5, 469
Foreign vessels	298	149, 975	201	126, 943
Total	609	347, 360	1, 116	675, 671

I am informed by the collector of customs at Charleston that the foregoing statement is not complete in so far that the number and tonnage of vessels below 100 tons are not given, and because a very large amount of coastwise trade does not pass through the custom-house, and is therefore not represented in the table.

Commerce in the years ending August 31, 1878 *and* 1886, *respectively.*

	1878.	1886.
Value of receipts of cotton, rice, naval stores, phosphate rock and other fertilizers	$23,713,112	$33,316,898
Value of manufactures, except fertilizers	3,500,000	6,761,000
Value of wholesale and retail trade	20,305,720	26,870,654
Total	47,536,832	66,948,552
Exports:		
Cotton, Upland and Sea Island ... bales	430,225	498,170
Rice ... barrels	41,843	69,497
Naval stores ... do	290,382	311,334
Phospate rock, crude and ground ... tons	120,490	198,588
Lumber ... feet, B. M.	9,595,053	27,615,705

The foregoing tables show that the trade and commerce of Charleston have largely increased since the commencement of operations for the improvement of the harbor, and there has been a decline of about 5 per cent. in the rates of freight and insurance, and in marine insurance of 50 per cent., during the same period; but these gratifying facts can not be ascribed to any improvement thus far secured by the works projected by the Government. At the same time it may safely be assumed that the successful completion of the project of improvement will result in a far greater development of the commerce of the port than will be possible without a material and permanent increase of depth in the channel over the bar.

I have no doubt that under the present plan the practicable low-water depth of 21 feet in the channel, equivalent to about 26 feet at mean high water, can be established—an increase of over 9 feet over the present depth of the bar channel. I am equally confident that a still greater increase in depth can be secured by adding to the length and height of the jetties. It has been roughly estimated that, other things being equal, the tonnage of a harbor the depth of the entrance to which has been increased, compared with its average tonnage before the channel had been improved, is in the proportion of the cubes of these depths. According to this estimate, the marine business of Charleston, when the jetties shall be finished and the desired depths on the bar secured, would be three or four times greater than at the present time.

When the present shifting and comparatively shallow channel of entrance shall be replaced by a single one of ample depth and permanently fixed in position, affording the most direct access from the sea to the inner harbor, the one needed element will have been supplied which, in conjunction with the natural advantages of the geographical situation of the port, its deep, capacious, and sheltered anchorage, its wharves and its railroad connections with the West and Southwest, will undoubtedly assure the development of Charleston into a great commercial city.

APPROPRIATIONS.

For several years past I have in my annual reports and in other official communications called attention to the necessity of making more liberal appropriations for completing the improvement of the entrance to Charleston Harbor. In the nine years which have elapsed since the first appropriation was made funds have been provided at an average rate of $165,000 per year, or *five and one-half per cent. of the amount of the estimated aggregate cost of the work.* The appropriation of $187,500 made in 1886 will, owing to the failure of the bill passed at the last se sion of Congress to become a law, have to serve for carrying on the wo for a period of two years, permitting an annual expenditure of on about 3 *per cent.* of the total estimated cost of the work, a sum whi might perhaps be deemed sufficient for annual repairs and maintenan of a work of this magnitude, but inadequate to an absurd degree f the successful prosecution of operations having in view the completi of the project within the present century.

In the half-finished condition of the jetties, deterioration durin periods when operations are suspended for want of funds is, naturall certain and rapid, and fully 40 per cent. of the amount last appropri ated has been expended in work which would have been unnecessary the funds required to secure a gradual but continuous development an consolidation of the structures had been more liberally and regular provided.

It is obvious, therefore, that while the current appropriations are i amounts that only slightly exceed the requirements for current repair the final completion of the jetties will be indefinitely postponed, if, i deed, it is *ever* accomplished. The inevitable results of the policy whic has obtained heretofore in the matter of supplying money for improv ments of this character, in their increased cost, in their exposure whi unfinished to serious damage if not total destruction, and in the co tingent losses which the delay in their completion causes the comme cial interests for the benefit of which they were designed, have bee suggested in previous reports and need not be again detailed. I desir however, to repeat my former recommendation that annual appropri tions of from $500,000 to $750,000 be made with a view to speedily an economically completing this important improvement.

With the balance of $83,153.61 on hand July 1, 1887, less $25,000 t $30,000 to be reserved for repairs during the next suspension of opera tions, the work of raising portions of both jetties to greater height with riprap stone will be carried on to the limit of the available fund A resurvey of the outer harbor will also be made.

This work is located in the collection district of Charleston, S. C., at the port o entry. Amount of duties collected in the calendar year 1886, $24,876.

Since the existing project of improvement was adopted the followin appropriations have been made:

By act of Congress approved June 18, 1878	$200,0
By act of Congress approved Mar. 3, 1879	200,0
By act of Congress approved June 14, 1880	170,0
By act of Congress approved Mar. 3, 1881	175,0
By act of Congress passed Aug. 2, 1882	300,0
By act of Congress approved July 5, 1884	250,0
By act of Congress approved Aug. 5, 1886	187,5
Total	1,482,5

Of this amount there had been expended, from the beginning of ope ations to June 30, 1887, the sum of $1,399,346.49, which includes th cost of building shore protections on Sullivan's Island and Mount Pleas ant, not provided for in the project for improving Charleston Harbo

Balance yet to be appropriated on the original maximum estimate $1,525,000.

The following drawings and papers accompany this report:

Sheet I. Chart showing the sites of the North and South Jetties, the progress mad in their construction to June 30, 1887, and the present depths on the bar.

Sheet II. Showing section of the North Jetty, and a plan of the mattress at variou points, as built to June 30, 1887.

made in 1886 w
sion of Congres
for a period of
about 3 *per cen*
might perhaps
of a work of th
the successful p
of the project w
In the half-fi
periods when o
certain and rap
ated has been e
the funds requir
consolidation of
provided.
It is obvious,
amounts that on
the final comple
deed, it is *ever* ac
has obtained her
ments of this ch
unfinished to ser
tingent losses w
cial interests fo
suggested in pre
however, to repe
tions of from $50
economically com
With the balan
$30,000 to be res
tions, the work o
with riprap stone
A resurvey of th

This work is locate
entry. Amount of d

Since the existi
appropriations ha

By act of Congress a
By act of Congress a
By act of Congress a
By act of Congress a
By act of Congress p
By act of Congress a
By act of Congress a

Total..........

Of this amount
ations to June 30
cost of building sh
ant, not provided
Balance yet to
$1,525,000.
The following d

VIN

LE

SHI

the

vari

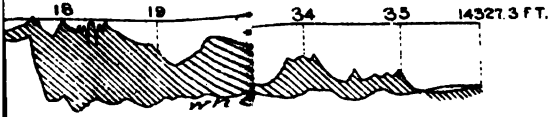
e

VIN

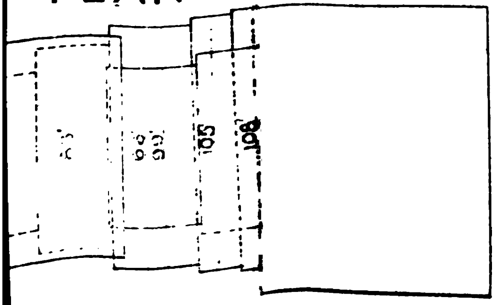
P

VING H
AT
LEST C
SHEET 2
the Nort
various p
e 30 188

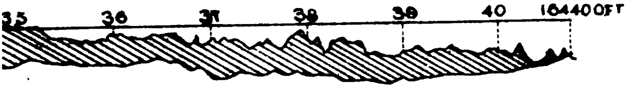
INAL

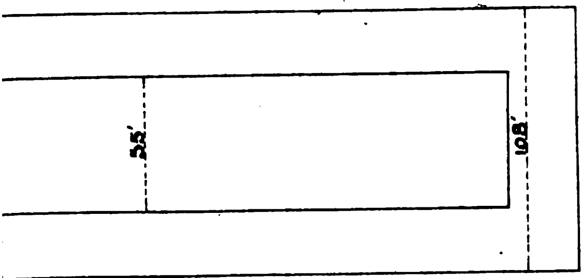


PLAN.



e
35





Accompanying annual report of July 30, 1887.
for the fiscal year ending June 30, 1887.

Q. A. Gillmore
Colonel of Engineers,
Bvt. Maj. Genl. U.S.A.

Sheet III. Showing section of the South Jetty, and a plan of the mattress at various points, as built to June 30, 1887.
Report of First Lieut. Frederic V. Abbot, Corps of Engineers.
Table of commercial statistics furnished by the collector of the port.

Money statement.

July 1, 1886, amount available		$55.00
Amount appropriated by act approved August 5, 1886		187,500.00
		187,555.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$81,145.46	
July 1, 1887, outstanding liabilities	23,256.03	
		104,401.49
July 1, 1887, amount available		83,153.51
Amount (estimated) required for completion of existing project		1,525,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		750,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for construction of jetties in Charleston Harbor, South Carolina, opened September 30, 1886.

No.	Names of bidders.	Mattresses, per square yard.	Stone, per cubic yard.	Aggregate cost of the work.
		Cents.		
1	P. Sanford Ross	85.9	$3.27	$87,290
2	Rittenhouse Moore	53	3.20	74,550
3	Anson M. Bangs	49	3.69	71,225
4	Alfred Ames Howlett	77	3.83	93,975

Contract awarded to Anson M. Bangs, at prices stated.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1887.

SIR: I have the honor to submit the following report of operations for improving the harbor at Charleston, S. C., during the fiscal year ending June 30, 1887:

On December 9, 1886, work on the jetties was resumed, the new contractor being Mr. Anson M. Bangs. Two thousand six hundred and eighty-six linear feet of additional apron was put in to the south of the South Jetty where it crosses the "deep pocket." It consisted of matresses loaded with 18 inches of stone, and increased the width of the jetty about 60 feet. It extended from a point 6,382 feet from the old shore end to a point 9,068 feet from the same. The intention is to stop the scour near the jetty produced by the overpour at ebb tide. Whether success has been attained will require some time to determine. The work was completed on March 16, 1887, at which time the plant was shifted to the North Jetty, and an additional foundation was laid over that portion of the jetty which crosses Drunken Dick Shoal. At this place a gap had been left in the original foundation, which was filled in 1881. The filling began to settle almost immediately afterwards, but after a time it seemed to nearly stop. The depth of water over the jetty here was from 7 to 12 feet at the last annual survey. The additional foundation just completed was 90 feet wide, and the loading was 18 inches of stone. It extends from a point 5,282 feet from the shore end to a point 7,418 feet from the same. It is thus 2,136 feet long. In addition to the load of 18 inches to each mattress as above reported, about 100 cubic yards of stone were deposited on the middle 20 feet of the jetty, on most of the mattresses; the distribution was, however, so regulated as to bring the jetty to as even a crest, 20 feet wide, as the quantity of stone would allow. This portion of the North Jetty is now nearly up to low water throughout its length. This work was completed early in June, and the plant was next shifted to the South Jetty at a point 13,500 feet from the old shore end. Here stone was deposited over the middle 36 feet of the work, 2.67 cubic yards being placed on each running foot of the jetty. The structure at this point is nearly up to low-water level, and is exposed to breakers a great part of the time. The stone is deposited to strengthen and preserve the work already done here.

Only 207 linear feet were completed at the end of the fiscal year.

It extends from 13,500 feet to 13,707 feet from the old shore end.

This work was so difficult that the contractor was allowed, at his request, to work simultaneously at a point known as the "deep pocket."

Here the jetty was low, due to the original depth of water in which it had been constructed, and the object to be attained was to raise its crest more nearly to the general level of the outer part of the jetty. The work consists of depositing stone along the middle 30 feet, 4.5 cubic yards being put on each running foot. At the end of the year 601 linear feet had been completed, extending from a point 7,206 feet from the old shore end to a point 7,807 feet from the same.

On June 30, 1887, the length of the foundation of the South Jetty was, as previously reported, 16,440 feet, that of the North Jetty foundation being 14,327 feet. Neither jetty has been lengthened during the fiscal year. The sea end of the South Jetty is 2,250 feet inside the outer 18-foot curve, and the sea end of the North Jetty 925 feet from the same, both distances being measured along the prolongation of the axes of the two jetties.

On the night of August 31, 1886, Charleston was visited by a severe earthquake, and for a time it was thought that the jetties might have been damaged, channels changed, and our reference points and stations moved. The Coast Survey made an examination which showed that the outer channels were practically unchanged, and a retriangulation which we made as soon as possible showed that our stations were not moved relatively. No effect upon the jetties has been discovered by careful examination. The building known as the old United States court-house, in which my offices were situated, was destroyed, and other offices were rented; all Government property was saved, with but little injury.

The annual survey of the harbor has covered a much greater area than is usual, and has been carefully executed at slight cost, as almost every time that I had a boat's crew to inspect the work I have secured soundings. The ground covered extends inward to the entrance of the Beach Channel, and to the north and south of the two jetties about half a mile. About 8,200 soundings were taken. Portions of the shores of Morris and Sullivan's islands have been surveyed. The jetties were examined by running a number of lines of soundings as nearly as possible along their axes, and from them the usual profiles have been constructed. To determine these profiles 3,000 soundings have been taken. Strong currents now set across the jetties, and they are so high that it is in many places difficult and dangerous to get over them even in a row-boat. This makes their examination by soundings more troublesome and uncertain each year. The high-water line of Mount Pleasant has been carefully surveyed, and also the shores of Hog Island Channel, at its western entrance. Hog Island Channel has been sounded from this entrance nearly to the Mount Pleasant Wharf. About 1,100 soundings were taken for this purpose.

CONDITION OF THE NORTH JETTY.

There is no marked change during the past twelve months, except where new work has been done. In places the jetty shows higher, and in others lower than on the profile submitted in June, 1886, but not more so than is easily accounted for by the extreme difficulty in keeping accurately on the center in taking the soundings. Where new work has been done the crest is nearly up to low-water level.

CONDITION OF THE SOUTH JETTY.

The examination of this jetty was postponed till the end of the fiscal year, as during June work was in progress at two points. After the end of the fiscal year windy weather prevented getting soundings, but not the continuation of the work, so that the profile shows some work done in the first two weeks of July.

There has generally been no marked change during the past twelve months except where new work has been done. In places the jetty shows higher and in others lower than on the profile submitted in June, 1886, but not more so than is easily accounted for by the extreme difficulty in keeping accurately on the center in taking the soundings.

At the shore end of the jetty a piece about 50 feet long seems to have gone out. This is almost exactly at the point where the jetty bottom rises above the low-water line on the beach.

For 50 to 75 feet inside of this the jetty shows some settlement. Inspection shows that at least half of the stone has been washed off the jetty to the northward. It lies on the beach, part of it being fully 15 feet from the edge of the mattress. This part of the jetty should receive more stone before long. The additional apron put in to the south of the South Jetty, where it crosses the deep pocket, had been in place such a short time at the end of the fiscal year that it is not possible to say whether it has stopped the cutting near the jetty or not. This action was comparatively slow before the apron was built, and at least a year must elapse before the failure to obtain deeper soundings south of the jetty can be said to indicate that the action has really been stopped.

Where stone has been deposited on the deep-pocket portion of the jetty from points 7,200 to 8,200 feet from "a" the crest is irregular as the profile shows, but there is a general raising of the jetty of about 6 to 10 feet in the former deepest part, and of 3 or 4 feet over the remaining portions of the 1,000 feet.

It is anticipated that more work will be done here before the end of the contract, the object being to fill up the deeper portions to the general level and thus obtain a more level crest.

At the outer end between points 13,500 and 15,000 feet from "a" the new work is about up to low-water level for the inner 200 feet, and the outer 500 feet shows the jetty 2 or 3 feet higher than last year. These are the only parts where the new work had been completed on this portion of the jetty.

The extreme outer end of the jetty shows several feet higher than it did last year, due to being more thoroughly sounded.

In comparing this year's profiles of the North and South jetties it should be borne in mind that this year from 6 to 10 lines have been run along the axes of the jetties, and the profile obtained from plotting all the soundings, while last year a number of cross-sections of the jetties were made, and the profiles constructed by connecting the shoalest soundings on consecutive cross-sections. The two are therefore comparable only in a degree.

SWASH CHANNEL.

A comparison of the surveys of 1886 and 1887 shows the following changes: Jim Evans Shoal, as defined by the 9-foot curve, is somewhat smaller in area, although the difference is not material when the soundings, but slightly over 9 feet, are considered. It has moved seaward, as heretofore, the crest having advanced about 150 feet. It appears this year subdivided into separate shoals, the most southern of which is somewhat nearer the South Jetty than the extreme southern point of this shoal last year. Swash Reef, as defined by the 9-foot curve, has not changed materially in size. It has moved seaward (at one point 300 feet), but that portion near the South Jetty has moved but slightly. Opposite the opening, between the jetties, the 12-foot curve has moved seaward, as has also the 15-foot curve. The 18-foot curve has not moved seaward, although it has changed its shape. The inner pocket, as defined by the 18-foot curve, has retired, but the 15 and 12 foot curves have advanced seaward. Old Swash Channel, which lies between Jim Evans Shoal and Swash Reef, and near the North Jetty, shows generally a deeper channel; but at the shoalest place, which is near the North Jetty and about 1,000 feet inside of its outer end, no greater depth is available. It is seriously obstructed as a navigable channel by two or three lumps of less than 9 feet, conspicuously by one near the sea-buoy. The dredged cut had disappeared last year as a cut, but greater depths still obtain where dredging was done than was shown by previous surveys. The area of shoal water between the jetties, defined by the 12-foot curve, has not materially changed. A general movement seaward of all material between the jetties, both inside and outside of Old Swash Channel, is indicated by this curve.

A comparison of the surveys of 1887 and 1884 shows the following changes: The area covered this year north of the North Jetty has not materially changed. South of the outer portion of the South Jetty the deep water (12 feet or over) near the jetty has advanced considerably seaward, so that there is now only 750 feet between the inner and outer 12-foot curves, near the outer end of the jetty. Between these curves there is, however, very shoal water to be crossed, and no immediate probability of a channel breaking through here is indicated. Almost parallel with this pocket there is another a little further to the south. This showed also on the map of 1884 it has narrowed and moved southward. Its inner 12-foot curve has also drawn back toward Morris Island. In 1884 there was but 400 feet between the inner and outer 12-foot curves of this pocket; this year there is more, but there is a narrow channel of nearly 12 feet through at this point. The shoal of less than 9 feet to the north of this last pocket has separated into several lumps, the aggregate area of which, as defined by the 9-foot curve, does not equal that of 1884. South of this pocket the 9-foot shoal is greater, and it has moved southwest. The outer curves to the south of the South Jetty have moved seaward, the 12-foot but slightly as a whole. In front of the jetties the 12-foot curve has advanced seaward 400 to 500 feet between 1884 and 1887, while the 15 and 18 foot curves show much less change. The deep pocket just east of the

Main Ship Channel and south of the South Jetty, as defined by the 18-foot curve, has been reduced in area. The depths near the jetty have increased, due to overpour at ebb tide. To prevent consequent settlement the additional apron reported as laid this year has been put in.

DRUNKEN DICK SHOAL.

The western end of this shoal has approached the Bowman Jetty, and the depth of water is less there than in 1884. South of Sullivan's Island the area of the shoal has diminished, and a deep pocket (12 feet and over) has made down towards the North Jetty. The average depth upon the shoal does not seem to have changed materially. The area between this shoal and Jim Evans has generally increased in depth, and that of Jim Evans within 12-foot curves has not greatly changed between 1884 and 1887. This last shoal, however, has advanced bodily 500 to 600 feet to the southeast during the last three years.

PUMPKIN HILL AND SOUTH CHANNELS.

No surveys of these channels have been made.

BEACH CHANNEL.

The advance of Drunken Dick Shoal has practically closed the entrance of this channel near the Bowman Jetty. Near the North Jetty it has changed but slightly. For two-thirds of the way from the Bowman Jetty to the North Jetty it has generally narrowed and shoaled.

SULLIVAN'S ISLAND.

The high-water line near the North Jetty and for 2,000 feet to the east has not materially changed. Between the North Jetty and the Bowman Jetty the shore has made a little west of Jetty B, as much as 120 feet. Just east of the Bowman Jetty it has not changed, but west of it it has cut away about 200 feet. The general slope of the beach has changed but little. The Palmetto foundation of the Bowman Jetty, locally known as the Long Grillage, has been exposed by the cutting on its western side. Jetty B is now entirely covered with sand, and but little of Jetty A shows for the same reason.

MORRIS ISLAND.

From 900 feet north of the South Jetty to the head of the island the high-water line has moved westward 330 feet since 1884. At the head of the island it has moved south 250 feet in the same time. At the South Jetty the change is very slight, but 2,000 feet further south the cutting away amounts to 180 feet. At the last point the island is narrower than formerly, due to the presence of a creek, which has not moved. Generally the island has moved as a whole; the sand forming the spit gradually covers the marsh to the rear, while the latter reappears on the front beach as the action continues. The slope of the beach has not changed materially except near the head, where it is steeper than in 1884.

The comparisons for Beach Channel, Sullivan's Island, Morris Island, and Drunken Dick Shoal are with the survey of 1884, since which date no survey of these localities had been made until this year.

HOG ISLAND CHANNEL.

The survey of 1887, compared with that of 1884, shows that the southwest point of Hog Island has cut away about 100 feet, and to the eastward of the point the cutting amounts to as much as 150 feet. The 12 and 18 foot curves have drawn back, showing a gradual widening of the entrance to the channel. Opposite Shem Creek the channel is not so deep by about a foot as was shown in 1885, but there is a through channel 12 feet deep. No examination of the outer part of this channel has been made.

MOUNT PLEASANT SHORE.

The spur jetties built in 1884 are in fair condition. Some stone has been thrown off from the crests, but not in sufficient quantity to injure their efficiency. The high-water line has been carefully surveyed, and a comparison with the survey of 1881 shows that near Shem Creek it has made 30 to 40 feet. Thence to the wharf of the Mount Pleasant and Sullivan's Island Ferry Company it has cut generally, although this action is checked by the existing private breakwaters, so that it only appears near the wharf, where it is 70 feet. East of the wharf the high water line has advanced in some places and receded in others. Generally, however, filling is indicated. This is not entirely due to the jetties, as the most notable advance occurs about 800 feet east of the wharf, and this is not presumably within their influence. No accurate surveys of the bluff line exist, but the indications are that this gradually recedes, due to the washing away of its foot by the waves. No accurate surveys of the high-water line of the Mount Pleasant shore have been made between 1881 and 1887.

Mr. James P. Allen, assistant engineer, has rendered most valuable and efficient service since the appropriation of 1886 made it possible to resume work.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Charleston, S. C., from January 1, 1875, to December 31, 1886.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
[illegible]	504	382, 018	11, 949	38	13, 144	326	198	88, 879	2, 404	740	484, 041	14, 379
[illegible]	471	340, 439	10, 113	44	11, 898	335	224	101, 272	2, 768	739	453, 609	13, 216
[illegible]	400	324, 919	9, 885	32	13, 972	308	236	105, 480	2, 851	668	444, 371	13, 044
[illegible]	396	322, 527	9. 623	44	19. 935	455	329	163, 368	3, 067	772	505, 830	14, 045
[illegible]	383	326, 681	10. 027	39	12, 505	319	246	121, 503	3, 292	668	460, 689	13, 638
[illegible]	441	388, 026	10, 641	38	12, 412	327	191	110, 771	2, 595	670	511, 209	13, 563
[illegible]	412	399, 732	10, 377	34	9, 430	272	257	121, 077	3, 073	703	530, 230	13, 722
[illegible]	410	384, 690	9, 446	35	4, 807	224	200	105, 647	2, 648	645	495, 144	12, 318
[illegible]	345	277, 538	7, 629	26	3, 002	157	239	113, 768	2, 958	610	394, 308	10, 744
[illegible]	425	304, 382	9, 822	21	3, 910	145	214	134, 076	3, 209	690	442, 368	13, 236
[illegible]	375	268, 477	9, 637	15	2, 344	97	187	106, 233	2, 586	577	377, 054	12, 320
[illegible]	901	550, 209	....	20	3, 714	131	182	114, 507	2, 644	1, 103	668, 408	......

CLEARED.

Year.	Coastwise.			American vessels.			Foreign vessels.			Total.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
[illegible]	461	328, 266	10, 830	57	24, 679	553	211	94, 595	2, 527	729	447, 540	13, 912
[illegible]	431	278, 744	9, 095	60	23, 598	546	230	103, 276	2, 812	721	405, 618	12, 453
[illegible]	335	234, 429	7, 719	35	22, 767	423	250	108, 446	2, 910	620	365, 662	11, 052
[illegible]	266	172, 988	5, 801	45	24, 397	479	398	149, 975	8, 591	509	347, 360	14, 045
[illegible]	287	188, 212	6, 268	34	11, 282	292	278	149, 052	3, 643	599	348, 546	10, 203
[illegible]	296	190, 733	6, 348	45	23, 210	481	246	155, 768	3, 375	587	369, 711	10, 204
[illegible]	268	187, 569	5, 942	32	9, 239	255	278	153, 796	3, 464	578	350, 604	9, 661
[illegible]	147	113, 690	3. 690	40	7, 375	273	263	158, 250	3, 584	450	279, 324	7, 546
[illegible]	98	48, 714	2, 018	27	4, 560	181	299	154, 653	3, 815	424	207, 927	6, 014
[illegible]	212	116, 020	4, 555	31	7, 845	217	276	161, 588	3, 727	519	285, 453	8, 499
[illegible]	191	99, 658	5, 017	24	5, 217	164	204	119, 602	2, 836	419	224, 467	8, 047
[illegible]	890	543, 259	....	25	5, 469	165	201	126, 943	2, 875	1, 116	675, 671	......

* Includes vessels which are not required to enter at custom-house.

COMMERCE.

Year.	Value of exports.	Value of imports.	Duties collected.
[illegible]	$19, 655, 966	$680, 343	$80, 656. 00
[illegible]	18, 098, 152	455, 562	89, 168. 00
[illegible]	16, 917, 492	161, 237	46, 848. 00
[illegible]	21, 167, 575	184, 127	36, 990. 00
[illegible]	18, 693, 126	127, 981	24, 070. 00
[illegible]	24, 939, 259	248, 158	46, 453. 98
[illegible]	21, 927, 269	723, 049	99, 066. 23
[illegible]	19, 907, 099	459, 970	45, 263. 33
[illegible]	20, 144, 365	467, 648	48, 760. 69
[illegible]	20, 833, 424	503, 504	36, 624. 76
[illegible]	15, 157, 889	588, 191	82, 741. 68
[illegible]	17, 410, 000	635, 000	24, 876. 00

Principal articles of direct foreign import and export passing through the custom-house of Charleston, S. C., from 1st of January, 1885, to 31st December, 1886.

IMPORTS.

Articles.	1885.		1886.	
	Quantity.	*Value.*	*Quantity.*	*Value.*
Sulphur .... tons..	11,275	$229,000	12,000	$226,000
Potash .... pounds..	2,457,000	39,000	4,747,000	48,000
Kainite .... tons..	16,338	92,000	15,500	91,500
Other fertilizers .... do...	7,623	78,000	6,000	59,000
Soda nitrate .... pounds..	703,404	10,000	513,000	11,000
Fruit	....	60,000	....	55,000
Free of duty	....	508,000	....	490,500
Malt liquor	....	11,000	....	13,000
Cotton ties .... pounds..	1,960,000	27,000	2,139,000	27,000
Cement .... barrels..	5,600	8,000	13,800	15,000
Coffee .... pounds..	5,020	500	1,207,000	75,000
Sundries	....	33,500	....	14,500
Dutiable	....	80,000	....	144,500
Total	....	588,000	....	635,000

EXPORTS.

Cotton .... bales..	276,290	14,070,800	336,376	16,390,800
Fertilizers .... tons..	13,146	91,582	5,800	38,331
Rosin .... barrels..	176,305	349,000	151,568	333,614
Turpentine .... gallons..	1,680,373	541,000	1,555,716	528,000
Cotton seed .... pounds..	539,310	7,000	562,713	4,600
Cotton-seed oil .... gallons..	83,191	40,000	105,668	43,400
Lumber, timber, staves	....	58,618	....	71,255
Total	....	15,158,000	....	17,410,000

THEO. D. JERVEY,
Collector.

N 2.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

The work of improving Wappoo Cut, South Carolina, with funds supplied by the General Government, was begun in November, 1882.

The appropriations, four in number, thus far made for it by Congress, aggregate $28,000.

Wappoo Cut is a narrow, tortuous, tidal stream, separating James Island from the mainland and connecting Stono and Ashley rivers. An examination of the creek was made under my direction some years ago, the report of which, with project of improvement, forms part of Appendix J 4, Annual Report of the Chief of Engineers for 1881, and is printed as House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The project of improvement contemplates the establishment of a straighter channel of 6 feet depth and 90 feet width at mean low water, and comprises the following details of work:

(1) Dredging on the bar at the entrance into Ashley River;

(2) A solid cut through the marsh at the end of the first easterly reach, 2½ miles from Ashley River;

(3) Dredging in Elliott's Cut and the reach leading to it, and on the bar at the outlet in Stono River;

(4) Closing by a light bulkhead the three tidal streams that enter this new route from the north;

(5) Building a jetty at the Ashley entrance to guide the flood tide into Wappoo Cut; and

(6) Building a jetty at the Stono entrance to guide the ebb tide into the cut.

The aggregate cost of these works was estimated at $34,000.

The delays in granting, and the insufficiency of amounts of appropriations, have rendered it impossible to complete the improvement at all points. The cuts already made but left unfinished are partially filled up from caving banks while operations are suspended.

From the necessity of doing part of the work over again, a considerable increase of the cost as originally estimated seems to be unavoidable.

OPERATIONS PREVIOUS TO JULY 1, 1886.

Operations were first commenced in November, 1882.

The bulk of the work has consisted in dredging. Elliott's Cut was improved through its entire length of about 2,000 feet by establishing a low-water depth of 6 feet on an average width of 60 feet. A solid cut of the same depth, average width 80 feet, and 800 feet long, was made through the marsh of "Devil's Elbow," securing a straight and convenient passage in place of the extremely tortuous route through the bend of that name. A channel of similar depth was dredged through the shallow bends from Elliott's Cut to the Marsh Cut. Some dredging was also done on the bar at the Ashley River entrance of Wappoo Cut. The material, consisting of sand, mud, and broken shells, removed by dredging, amounted in the aggregate to 117,000 cubic yards.

A number of snags, stumps, and overhanging trees were removed and a bulkhead was built across the mouth of Pompey's Cut, a tidal branch entering Wappoo Cut at the upper end of Elliott's Cut, which had heretofore carried sand and mud into the channel of navigation.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Although an appropriation of $5,000 has been available, no work was done except making a survey during the latter part of the year.

The navigable channel improved by former operations was found to be in tolerably fair condition, and it was deemed best to retain the funds last appropriated until the shoals should again become troublesome to navigation, as the amount available for work was not considered to be sufficient to commence the construction of permanent works or do more than remove local obstructions that might form in the channel.

CONDITION AND EFFECTS OF THE WORK.

A careful survey made in March, 1887, has shown that there was then a good channel with over 6 feet at mean low water throughout Wappoo Cut, with the exception of a small bar at the mouth of Pompey's Cut, over which, however, 5½ feet could be carried.

In Elliott's Cut the channel has retained its depth, but has narrowed considerably.

The work thus far done has resulted in a decided deepening of the navigable channel, which previous to 1882 had only low-water depths, ranging from 1 foot to 4 feet in the shallow reaches of the westerly section of Wappoo Cut, where nearly all the operations have been carried on. In consequence of the continued narrowing of the improved channel in these reaches, caused by caving banks, it is expected that some dredging will have to be done very soon.

GENERAL REMARKS.

Wappoo Cut is undoubtedly of considerable commercial value. It forms a portion of the only inland route for navigation between Charleston Harbor and the country south of it. I am informed that during the past fiscal year the aggregate tonnage of all kinds of vessels passing through the cut was 110,000 tons, while the total value of staple articles of commerce, consisting of phosphate rock, fertilizers, cotton, rice, vegetables, and lumber, was estimated at $980,000.

No commercial statistics for the year 1882, when the improvement was commenced, are obtainable, nor can I state whether the work thus far done by the Government has had any effect upon the rates of freight and insurance.

It is conceded that the work performed by straightening and deepening the route has resulted in materially improving the navigation of Wappoo Cut. Steam-boats passing through can now make their trips with regularity and much greater convenience.

The cut is still lacking in depth at some parts, and the width of 90 feet, which the channel is contemplated to have under the existing project, has not yet been established. I have no doubt that when these dimensions shall have been secured by completing the improvement the commerce and navigation through this route will be essentially benefited and increased.

With the balance of $5,000.37 on hand on July 1, 1887, it is contemplated to resume dredging at those portions of Wappoo Cut where local examinations may show such work to be necessary.

The following appropriations have been made for this improvement:

By act of Congress approved March 3, 1881	$10,000
By act of Congress passed August 2, 1882	10,000
By act of Congress approved July 5, 1884	3,000
By act of Congress approved August 5, 1886	5,000
Total	28,000

The total expenditures to June 30, 1887, were $22,999.63.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry. Amount of duties on imports collected in 1886, $24,876.

Money statement.

July 1, 1886, amount available	$31.60
Amount appropriated by act approved August 5, 1886	5,000.00
	5,031.60
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$31.23
July 1, 1887, amount available	5,000.37
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

N 3.

IMPROVEMENT OF ASHLEY RIVER, SOUTH CAROLINA.

A sum of $5,500 has thus far been provided by Congress, in four different appropriations, for improving Ashley River, South Carolina.

The first appropriation, of $1,000, was made by act approved June 14, 1880.

Ashley River was examined and partially surveyed under my direction, under a provision of the act of March 3, 1872. My report, with project of improvement, is printed as Appendix S 8 of the Annual Report of the Chief of Engineers for 1873.

The plan of improvement recommended comprised:

(1) The removal of a shoal or bar at a place known as Accabee, between 7 and 8 miles above Charleston City, where only 9 feet of water at mean low tide was found in 1873, while the channel of approach to it from below was only about 40 feet in width between the 10-foot curves.

(2) The removal of a shoal at a point below the Wando Phosphate Works, about 2 miles above Accabee, where only 6 feet of water was found at low tide.

It was proposed to lower these shoals by dredging to a low-water depth of from 10 to 11 feet.

The mean rise and fall of tides in Ashley River is about 5 feet.

The cost of the work was estimated at $5,000.

No work was done during the past fiscal year.

With the approval of the Department, the sum of $1,000, appropriated by act approved August 5, 1886, is held for the present, to be expended when necessary in dredging on one or both of the shoals where work has been done, should the cuts fill in, or at any other point on the river which may shoal to a low-water depth of less than 10 or 11 feet.

In February, 1882, and in April and May, 1886, two shoals with deficient depths of water over them were dredged to low-water depths of from 10 to 11 feet, on widths varying from 100 to over 200 feet; the improved channels connecting with the low-water curves of corresponding depth at their ends. One shoal is situated at Accabee, about 8 miles above the city of Charleston; the other about 2 miles further up the river, near the Wando Phosphate Works.

The material removed consisted of sand and mud, and amounted in the aggregate to 22,124 cubic yards.

At the end of the preceding fiscal year the improved reaches were in satisfactory condition, and they have so continued during the year just closed.

The appropriations made to date exceed the estimated cost of the improvement by $500, but the expenses thus far incurred are less than the estimate. Although the improvements have been satisfactorily maintained, it is probable that an enlarged project may eventually be required to render them practically permanent by providing suitable works of contraction to concentrate the currents over the shoals. There exists, however, at present no necessity for recommending the adoption of such a revised project.

REMARKS ON THE COMMERCE OF ASHLEY RIVER.

The traffic of Ashley River consists chiefly in the transportation of phosphate rock mined in the vicinity of the upper reaches of the river.

As far as known, this industry began in 1868; a cargo of 100 tons of rock, shipped on April 14 of that year, is considered to be the first ever sent down the river.

I have been unable to obtain commercial statistics of the river for 1882, in which year the first work of improvement was done. According to information believed to be trustworthy, the commerce passing over Ashley River in the fiscal year ending June 30, 1887, was as follows:

150,000 tons of phosphate rock	$675,000
30,000 tons of sulphur, kainit potash, and other fertilizing material	750,000
Total value	1,425,000

During the same period the tonnage of steamers, tugs, sailing vessels, and other craft using the river was 275,000 tons.

Rates of freight on the river are admitted to have been lowered, due to the dredging done by the Government. Vessels of greater tonnage, capacity, and draught can now pass over the shoals that formerly obstructed navigation. The proportion of reduction of rates has not been stated.

Regarding the prospective advantages to commerce that may ensue by the completion of the improvement, I would say that the work as contemplated by the existing project is nearly completed. The channels heretofore dredged require enlargement at some places, and, as I have already stated, a revised project may have to be prepared at some future time with a view of rendering the improvement permanent.

Judging from results obtained, the final completion of the project should prove beneficial to commerce. Since the river has been improved vessels of as much as 800 and 1,000 tons, drawing 15½ feet of water, have been employed, while previously vessels of from 400 to 500 tons and 12½ feet draught represented the limit of safe navigation. It may be claimed that Ashley River, in its present condition, can be regarded as a locality where the improvement secured is exceptionally large in proportion to the expenses incurred for it, but the improvement is local in a conspicuous degree.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry. Amount of duties collected in 1886, $24,876.

Since the plan of improvement was adopted the following appropriations have been made:

By act of Congress approved June 14, 1880	$1,000
By act of Congress approved Mar. 3, 1881	1,500
By act of Congress approved July 5, 1884	2,000
By act of Congress approved Aug. 5, 1886	1,000
Total	5,500

The total expenditures to June 30, 1887, were $4,468.46.

Money statement.

July 1, 1886, amount available	$42.74
Amount appropriated by act approved August 5, 1886	1,000.00
	1,042.74
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	11.20
July 1, 1887, amount available	1,031.54

N 4.

IMPROVEMENT OF EDISTO RIVER, SOUTH CAROLINA.

Three appropriations, aggregating $16,000, have thus far been made by Congress for improving Edisto River, South Carolina.

The Edisto is one of the principal rivers of South Carolina. It is formed by the junction of the North and South Forks, which unite in the southern part of Orangeburg County. The South Fork, commonly known as the South Edisto, is the main river. It empties into the ocean near St. Helena Sound.

Edisto River was examined under my direction with a view to its improvement in September and October, 1880. My report, dated December 31, 1880, with project of improvement, is printed as Appendix J 15 of the Annual Report of the Chief of Engineers for 1881, and also as part of House Ex. Doc. No. 23, Forty-sixth Congress, third session.

It is contemplated to improve the river from Guingard's Landing, in Aiken County, to the mouth, a total length of 260 miles, so as to establish a safe navigation at all seasons of the year for light-draught steamboats from the sea to the junction of North and South Forks, near the crossing of the South Carolina Railroad, 183 miles from the mouth, and thence to Guingard's Landing for rafts and flat-boats.

It is not deemed advisable to attempt an improvement of the reaches higher up, which are excessively encumbered with logs and shoals.

The obstructions to navigation consist of numerous bends, logs, snags, overhanging trees, and piles, and also of shoals composed generally of sand, but in some places of hard clay.

The project of improvement comprises the following details of work:

(1) Enlargement and clearing of all the new channels now in process of formation.

(2) Forming new channels across necks of bends where needed.

(3) Shutting off lateral arms which now weaken the stream.

(4) Removal of logs, snags, and pile obstructions.

(5) Removal of shoals of sand and clay in one case by building a deflecting jetty.

The total cost of the project was estimated at $33,385.

There exists no reason at present for exceeding this estimate.

OPERATIONS PREVIOUS TO JULY 1, 1886.

Operations on Edisto River, which have been carried on at intervals, partly by the United States snag-boat *Toccoa* and partly by hired labor, were first commenced in March, 1883.

Pile obstructions were removed from near Willtown, 30 miles from the mouth of the river, and from the vicinity of the Charleston and Savannah Railroad Bridge at Jacksonborough, 9 miles higher up; also fragments of the wreck of a steam-boat near Willtown.

From the reaches of the river, extending from its mouth to Kennedy's Bridge, a distance by river of 130 miles, 11,223 logs, snags, and overhanging trees, varying from 12 to 72 inches in diameter, were removed, in many cases requiring the use of dynamite. Numerous outlets into the swamps, and several incipient natural cut-offs, known as sucks, were closed.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

With the appropriation of $3,000 made by the act approved August 5, 1886, operations were resumed on October 27 and terminated on December 15, 1886. They consisted in the removal from the channel of 2,966 snags, 12 stumps and logs, 479 stumps, 1,208 logs, 324 overhanging trees, 142 hurricanes, or trees or stumps with the roots still on, such as would have blown or fallen into the river from a caving bank, and 1 raft of sunken timber. Five outlets were closed, through which water escaped from the river into the adjoining swamps, and one "suck" or natural cut-off was cleared and opened.

The operations extended from McLeod's Suck, about 7 miles above Jacksonborough, to the vicinity of the South Carolina Railroad Bridge, 143 miles higher up. They were carried on by means of hired labor, as from the nature of the work no contract could have been made without allowing an excessive margin for contingencies.

The river is in good condition where it has been improved.

No work can be done during the present fiscal year unless funds should be provided by Congress and made available before the close of the year.

GENERAL REMARKS.

The principal business done on Edisto River consists in the rafting of timber and lumber. I am unable to state the quantities shipped in 1883 when the work of improvement was begun. For the past fiscal year it is estimated that from 40,000,000 to 50,000,000 feet of lumber and timber were shipped, besides large quantities of cross-ties, naval stores, etc. The aggregate tonnage of other articles of commerce shipped in 1883 and 1886, respectively, is reported to have been as follows: In 1883, 35,000 tons; in 1886, 60,000 tons.

The cost of shipping the products of the saw-mills on the Edisto is said to be now 25 per cent. less than formerly, which saving is to a great extent credited to the improvements made by Government. It is not known to me whether the works have affected the rates of freight of the South Carolina Railroad and of the Charleston and Savannah Railroad, both of which cross the Edisto, and may be considered as competing roads of transportation.

The prospective advantages of completing the improvement of the river and kéeping it in good order are of sufficient importance to make it desirable that the necessary funds still required under the existing project should be supplied. It is expected that large sections of well-timbered country will gradually be developed which until now have practically been inaccessible. Yellow pine has thus far been the only kind of timber that could be floated to market. When the improvement is completed large areas, stocked with other species of valuable timber, such as cypress, various kinds of oak, hickory, birch, beech, and many varieties of gum, will become accessible to the axman.

I respectfully repeat my recommendation that the necessary appropriation be made to complete the improvement in conformity to the approved project. The balance still required for the purpose is $17,385.

This improvement is located in the collection district of Charleston, S. C. Charleston on the north and Beaufort on the south are the nearest ports of entry.

Duties on imports collected in 1886 at the custom-house of Charleston, S. C., $24,876; at Beaufort, S. C., $1,297.58.

Since the present project of improvement was adopted the following appropriations have been made:

By act of Congress passed August 2, 1882	$8,000
By act of Congress approved July 5, 1884	5,000
By act of Congress approved August 5, 1886	3,000
Total	16,000

The total expenditures to June 30, 1887, were $15,818.85.

The report of First Lieut. F. V. Abbot, Corps of Engineers, is transmitted herewith.

Money statement.

July 1, 1886, amount available		$280.67
Amount appropriated by act approved August 5, 1886		3,000.00
		3,280.67
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,105.52	
July 1, 1887, outstanding liabilities	6.00	
		3,111.52
July 1, 1887, amount available		169.15

Amount (estimated) required for completion of existing project	17,385.00
Amount that can be profitably expended in fiscal year ending June, 30, 1889	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1887.

SIR: I have the honor to submit the following report of work done for improving Edisto River, S. C., during the fiscal year ending June 30, 1887.

Work began on October 27, 1886, and continued until December 15, 1886, at which time the appropriation was nearly exhausted.

The character of the work required it to be done by hired labor.

The following obstructions were removed: Snags, 2,966; stumps and logs, 12; stumps, 479; logs, 1,208; hurricanes, 142; rafts of sunken timber, 1; overhanging trees, 324. They were distributed as follows:

Locality.	Snags.	Stumps and logs.	Stumps.	Logs.	Hurricanes.	Trees.
South Carolina Railroad Bridge to Cooner's Bridge.	560	12	79	165	....	....
Cooner's Bridge to Fred Stokes Landing	253	....	29	112	....	....
Fred Stokes Landing to Richardson's Bridge to Shingle Landing	310	....	74	188	....	....
Shingle Landing to Old River and Smokes Sucks.	546	....	66	175	....	....
Old River Suck to High House Landing	408	....	40	149	....	....
High House Landing to Rentz's Ferry	310	....	73	137	....	....
Rentz's Ferry to Taff Rump Suck	323	....	6	38	....	....
At Taff Rump Suck	80	....	69	197	10	44
Taff Rump Suck to Campbell's Landing	....	....	7	28	25	22
Campbell's Landing to Indian Field Creek to Saw Mill Landing	80	....	18	......	42	100
Near Saw Mill Landing	....	....	....	2	1	51
Quackenbush Landing to Good Hope Landing to Sullivan's Ferry	104	....	11	46	35	8
Ishmael's Stumps to McLeod's Suck	42	....	7	21	29	44

McLeod's Suck is about 6 or 8 miles above Jacksonboro, Good Hope Landing about 40, Taff Rump Suck about 90, and the South Carolina Railroad Bridge about 150. These distances are mere approximations, as no accurate measurement of the river length is known to have been made.

Sucks were closed at the following points, about 3 miles below South Carolina Railroad Bridge, just below Cooner's Bridge, between Cooner's Bridge and Fred Stokes Landing, about 2 miles below Campbell's Landing, and at McLeod's. Also three small outlets near Fred Stokes Landing.

Taff Rump Suck was opened, and a small island known as Bark Island was cut away.

I am indebted to Mr. J. D. Ackerman of Cottageville, S. C., for the information that about 40,000,000 to 50,000,000 feet of lumber and timber were shipped down the Edisto during this fiscal year, in addition to large quantities of pine and oak wood, cross-ties, naval stores, etc., and that the cost of transportation is 25 per cent. less than before the improvements were made.

Dr. A. E. Williams, of the same place, informs me that the losses by breaking up of rafts of timber are not more than one-quarter as great as they were before the improvements were begun on the river.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

N 5.

IMPROVEMENT OF SALKAHATCHIE RIVER, SOUTH CAROLINA.

Three appropriations have been made by Congress for the improvement of Salkahatchie River, South Carolina, aggregating $10,000.

The river was examined under my direction during the latter part of 1880, and my report of the examination, dated December 29, 1880, is printed as Appendix J 16, Annual Report of the Chief of Engineers for 1881, and as part of House Ex. Doc. No. 23, Forty-sixth Congress, third session.

The Salkahatchie River, also named the Big Salkahatchie, to distinguish it from one of its tributaries, known as the Little Salkahatchie, rises in Aiken County, S. C. These two rivers unite about 80 miles from the Atlantic seaboard. About 24 miles below the junction the Salkahatchie is spanned by the Charleston and Savannah Railroad Bridge. Further down the river is known as the Combahee, which discharges into St. Helena Sound about midway between the cities of Charleston and Savannah. The mean rise and fall of tides in St. Helena Sound is 5.9 feet. At the railroad crossing, nearly 60 miles from the river's mouth, it is 2.5 feet, and the tidal oscillation reaches a point about 20 miles higher up.

PROJECT OF IMPROVEMENT.

The project contemplates the creation of a continuous and practicable channel for rafts and flat-boats in the lower reaches of the river from a point 5 miles above Toby's Bluff down to Hickory Hill, 12 miles below the railroad bridge and 46 miles above the river mouth, comprising a total length of river 77 miles.

The work would comprise the removal of piles at Hickory Hill and the removal of logs and of the shoals accumulated around them in the reaches above the bridge.

Through Murdock's and Weekly Sand Drags, where the Salkahatchie divides into numerous insignificant streamlets, cuttings must be made to form a channel of sufficient dimensions for rafts and flat-boats.

The cost of this improvement is estimated at $18,000. It is believed that the original estimate will not be exceeded.

OPERATIONS PREVIOUS TO JULY 1, 1886.

The lowest (12-mile) reach of the river, from Hickory Hill up to the Charleston and Savannah Railroad Bridge, was cleared of obstructions by the United States snag-boat *Toccoa*, which removed from the channel 16 piles and 106 stumps, snags, and overhanging trees. This was the first work done with funds furnished by Government. It was commenced in June, 1883. Higher up, from the bridge to the "Forks," a distance of 21 miles, the river was thoroughly cleared of obstructions. In the upper reaches, between the Forks and Braxton's Ford, an aggregate length of 39 miles, a large amount of work was accomplished by removing obstructions, straightening the course of the river, and shutting off lateral channels. The snags, stumps, logs, and overhanging trees taken from the channel and banks aggregated 11,240; over 100 outlets were closed, 2 shoals or islands were removed, 26 mud and sand points were cut off, and the banks were trimmed at numerous places.

Raft navigation was materially benefited by the work here briefly described.

Above the railroad bridge operations were carried on by hired labor, the work being of such a miscellaneous character as to render it impracticable to do it by contract without allowing an excessive margin for contingencies. The method adopted proved entirely satisfactory.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

With the funds last appropriated operations were resumed on the reaches extending from the Charleston and Savannah Railroad Bridge to a point 77 miles above, in October, 1886, and continued until December 15 of that year. The stage of the river during the period indicated was unusually favorable for work, which was performed, as heretofore, by hired labor. Six hundred overhanging trees, logs, stumps, snags, etc., were removed; 1 dam was built, to remove a local shoal; 29 outlets were closed, to prevent loss of water into the swamps; 1 "suck" was opened, providing thereby a better channel, while 1 bad suck was closed; and a projecting point was cut off.

REMARKS ON THE CONDITION AND COMMERCE OF SALKAHATCHIE RIVER.

It is understood that about forty years ago the State of South Carolina appropriated some $30,000 for the improvement of the Salkahatchie. I am not aware of the place according to which this sum, or a part of it, was expended; but the examination made under my direction in 1880 showed the river to be for over 100 miles unfit for navigation during low stages of the water, for small rafts and the lightest kind of flatboats. At several places there was actually no river, it being divided into numerous insignificant streamlets. Of any work that might have been done, nothing apparently remained in 1880 except the narrow and shallow channel of "Weekly Sand Drags." The improvements effected since 1883 have brought the river, in the long reaches where work has been done, to a much better condition than it ever had, so far as my information goes.

The chief traffic of the Salkahatchie consists in timber and rice. I regret that I have not been able to obtain reliable statistics concerning these staples for any year except 1884, in which year 6,800,000 feet of timber and 200,000 bushels of rice are reported to have been shipped. I have been informed, however, that a new saw-mill has lately been built near Toby's Bluff, and that a new mill at Beaufort, S. C., is supplied with logs from the Salkahatchie; also that, owing to the improvements made by Government, the river traffic has trebled compared with the business done in 1883, while the cost of transportation is now from

33 to 50 per cent. less than in that year. Judging from the favorable results already obtained, it is apparent that the completion of the proposed improvement will be followed by further development of the business on the river. It is estimated that over 1,600,000,000 feet of timber is standing within more or less accessible distances from the river up to Niles' Bridge, 68 miles above the Charleston and Savannah Railroad Bridge. When the existing project shall have been completed, the expense of rafting will undoubtedly be still further reduced, increased quantities of timber and other staples will be transported, and the community will be benefited by the ensuing lowering of the price of these commodities.

I would, therefore, respectfully recommend that the funds be supplied for completing the improvement. The balance to be still provided for by appropriations is $8,000.

This work is located in the collection district of Charleston, S. C. Beaufort is the nearest port of entry. Duties on imports collected at the custom-house of Beaufort, S. C., in 1886, $1,297.58.

Since the present project of improvement was adopted the following appropriations have been made:

By act of Congress passed August 2, 1882	$5,000
By act of Congress approved July 5, 1884	3,000
By act of Congress approved August 5, 1886	2,000
Total	10,000

The total expenditures to June 30, 1887, were $9,638.66.

The report of First Lieut. F. V. Abbot, Corps of Engineers, and a table of commercial statistics furnished by the collector of the port of Beaufort, S. C., are transmitted herewith.

Money statement.

July 1, 1886, amount available	$75.83	
Amount appropriated by act approved August 5, 1886	2,000.00	
		$2,075.83
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,708.49	
July 1, 1887, outstanding liabilities	6.00	
		1,714.49
July 1, 1887, amount available		361.34
Amount (estimated) required for completion of existing project		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		8,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1887.

SIR: I have the honor to submit the following report of work done for improving Salkahatchie River, South Carolina, during the fiscal year ending June 30, 1887.

Work began on October 19, 1886, and was stopped on December 15, 1886, when the funds were nearly exhausted. The character of the work done necessitated the use of hired labor.

The following obstructions were removed: Overhanging trees, 239; logs and stumps, 169; trees and tree tops, 119; hurricanes, 52; stumps, 15; snags, 7; distributed as follows:

Locality.	Over-hanging trees.	Logs and stumps.	Trees and tree tops.	Hurri-canes.	Stumps.	Snags.	Miles.
Five miles below Broxton's Bridge to Toby's Bluff	11	13	20	......	......	......	77 59
Toby's Bluff to Du Bois Sand Drags	24	42	32	1	......	......	......
Du Bois Sand Drags to Niles's Bridge	1	1	5	......	......	......	46
Niles' Bridge to Weekley's Sand Drags	9	4	1	1	......	......	......
Weekley's Sand Drags to "Roots"	4	4	......	8	2	5	......
"Roots" to "Forks"	1	1	......	......	......	2	24
Forks to Benton's Landing	142	63	23	16	8	......	......
Benton's Landing to Cochran's Suck	24	23	22	19	1	......	......
Cochran's Suck to Charleston and Savannah Bridge Railroad	23	18	16	12	4	......	......

The water was very shoal in the river at the Du Bois Sand Drags, at Weekley's Sand Drags, and at the Roots, due to the loss of water from the river proper into the swamps on either side. To increase the depth, 9 outlets into the swamps were closed just above the Du Bois Sand Drags, 19 in the vicinity of Weekley's and the Roots, and 1 below the latter at another shoal place. A projecting point of land at the lower end of the Weekley's was cut away. McTeer's Suck was closed to prevent a threatened cut-off, and Cochran's Suck was opened fully, as this was really the better arm of the river. One dam was built to remove a local shoal.

Mr. W. D. Niles, of Hampton County, S. C., informs me that the business passing over the river has increased. A new saw-mill has been erected near Toby's Bluff; a new mill at Beaufort, S. C., is now supplied with logs from this river, and considerable quantities of naval stores and cross-ties are now shipped by river.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Beaufort, S. C., from January 1, 1881, *to December* 31, 1886.

ARRIVED.

Years.	Coastwise.		Foreign ports.				Total.	
			American vessels.		Foreign vessels.			
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1881	89	90,813	4	2,806	123	32,090	216	125,709
1882	91	111,026	2	450	86	34,790	179	146,266
1883	94	99,540	2	174	76	37,648	172	137,362
1884	97	103,658	......	......	53	36,497	150	140,155
1885	94	99,272	1	106	77	63,867	172	163,245
1886	112	123,491	1	506	44	33,830	157	157,827

CLEARED.

1881	56	46,477	......	......	137	69,404	193	115,881
1882	57	72,773	2	743	114	71,224	173	144,740
1883	61	65,142	2	368	107	76,093	170	141,603
1884	58	64,764	1	78	93	79,686	152	144,528
1885	51	59,411	1	106	113	101,586	165	161,103
1886	59	62,977	......	......	100	102,022	159	164,999

Arrivals and clearances of vessels, and commerce at Beaufort, S. C.—Continued.

COMMERCE.

	Value of exports.	Value of imports.	Duties collected.
1881	$1,393,728	$135 766.40	$14,540.21
1882	702,131	35,868.58	199.30
1883	1,061,634	25,958.40	1,923.48
1884	827,679	20,320.07	8,223.29
1885	1,011,629	42,146.73	10,945.62
1886	1,058,681	7,771.43	1,297.58

H. W. RICHARDSON,
Collector.

N 6.

IMPROVEMENT OF SAVANNAH HARBOR AND RIVER, GEORGIA.

Operations for improving Savannah Harbor and River, Georgia, were during the past fiscal year carried on in conformity with the enlarged project based upon an examination made in compliance with section 3 of the river and harbor act, approved March 3, 1881. My report of the examination, with project and estimate of cost, dated January 16, 1882, is printed as part of Appendix J 4, Annual Report of the Chief of Engineers for 1882, and also as Senate Ex. Doc. No. 19, Forty-seventh Congress, first session.

As required by the act referred to, the present project contemplates increasing the depth of water in Savannah River and Harbor, from the bar up to the city, to 22 feet, and widening the channel of the river opposite the city to 600 feet, of uniform depth with the balance of the channel.

The project is essentially an enlargement of two previous plans, dated August 28, 1873, and March 19, 1879, respectively, according to which operations for improving Savannah Harbor and River have been carried on since 1874. The details of these earlier plans have repeatedly been given in my former annual reports.

During the two years preceding the autumn of 1873 Congress had appropriated the aggregate sum of $100,000 for improving the river below the city of Savannah, which was expended mainly in removing wrecks, cribs, and other obstructions.

By act approved February 27, 1874, the sum of $193,132.96 was appropriated for the relief of Mr. Henry S. Wells, for work done by him in removing wrecks, cribs, etc., under contracts with the Treasury Department of May 1 and July 5, 1866.

PLAN OF IMPROVEMENT.

The main features of the present consolidated or enlarged plan of improvement are as follows:

A dam at Cross Tides, 4 miles above the city of Savannah. Enlargement of the water-way opposite the city front.

New bulkhead above Kinsey's Mills, opposite the city. Adoption of the north channel of Savannah River for final improvement, in preference to the south channel, from the head of Elba Island to the head of

Long Island, which required the construction of a low dam across south channel near its upper end, and closing the lateral channels connecting the north channel with the south channel, from Elba Island to Cockspur Island.

Training-walls and wing-dams on all reaches from the city to Tybee Roads, for contracting the river where it is of excessive width; also shore protections where they are deemed necessary.

Deepening, widening, and straightening the river by dredging at various points between Cross Tides and Tybee Roads.

For further details of the project I beg leave to refer to my annual report for the fiscal year ending June 30, 1882.

The total cost of the improvement, in accordance with the enlarged project of January 16, 1882, was estimated at $730,000, in addition to the sum of $482,000 appropriated previous to that date.

OPERATIONS FROM JULY 1, 1874, TO JUNE 30, 1886.

At Cross Tides a dam was constructed, formed of brush mattresses, fascines, and riprap stone, designed to divert a larger volume of water at ebb tide into Front River passing the city of Savannah. The ends of the dam connect with rice dikes on Hutchinson's and Argyle islands, respectively; its total length is 1,025 feet. The work has been frequently damaged by settling, and also by fishermen who frequently throw large quantities of stone off the dam to open a passage for small boats, affording them a shorter route from the Back River to the city of Savannah. The dam has been repaired repeatedly, yet on June 30, 1886, its crest was again for a length of nearly 300 feet several feet below the level of high water, to which it had previously been raised.

About 70 linear feet of the old King's Island crib jetty, near Cross Tides, was removed to facilitate the flow of water into Front River.

Three wing-dams, composed of log mattresses and riprap stone, were constructed opposite the lower part of the city of Savannah, to contract the water-way and increase the strength of currents over Garden Bank Shoal.

A training-wall, known as Fig Island Jetty, was built for a length of about 6,000 feet down-stream from a point a little above the lower end of Fig Island. The jetty runs about parallel to the right bank of the river, forming, as far as it extends, the left bank of the channel at "The Wrecks." The work is constructed of log and brush mattresses, brush fascines, and riprap stone. On its channel side it is provided with eleven short spurs, of similar construction, placed at right angles to the axis of the Wrecks Channel. The crest of the jetty rises to the level of 5 feet above mean low tide.

A spur-jetty was built from the left bank of Front River about 480 feet above the shore end of Fig Island Jetty, for better regulating the ebb flow into the channel at the Wrecks.

Two dams (Nos. 5 and 11½) close lateral channels on either side of Barnwell's Island, opposite Fort Oglethorpe.

A submerged dam was constructed across the south channel a short distance below the head of Elba Island. It is designed to divert more water at ebb tide into the north channel, which is being improved. The crest of this work may eventually have to be raised to a higher level.

A wing-dam (No. 15), starting from a mud island named Barnwell Island No. 3, contracts the water-way at the upper end of Elba Island.

Three lateral channels, formerly connecting the north and south channels, have been closed. One of the dams closes Philbrick's Cut, at the lower end of Elba Island; another, "Big Gap Dam," passes across the channel between Island One-and-Two and Bird Island; while the third closes the passage between Bird Island and Long Island.

Considerable work has been done in improving the north channel from Elba Island to the mouth of the river, with a view of deepening the shallow reaches at various places where the water-ways were of excessive width. These shoals are found at the crossings where the navigable channel or main line of currents is deflected from one bank to the opposite one. The first of these crossings is known as the "Upper Flats," which extend from the lower end of Spirit Island to the deep water-way abreast of the middle and lower north shore of Elba Island. Three pairs of wing-dams were built here to contract the water-way and direct the currents across the "Flats." They are numbered 4 and 23, 6 and 25, 10 and 27, respectively.

The next shallow crossing improved is named "Lower Flats," or "Cabbage Tree Crossing." These shoals separate the deep pool at the lower end of Elba Island from the deep waters on the opposite shore, in the vicinity of Venus Point, Jones Island. One pair of wing-dams (14 and 29) and a single dam (13) were built here. The last named was not finished, and the two others were damaged by a cyclone in August, 1885.

The third crossing, called Long Island Crossing, extends from the lower end of the anchorage grounds off Venus Point across the river to the deep waters abreast of the lower half of Long Island. To improve this reach, wing-dams 26 and 33 were built. They were considerably injured by the cyclone of August, 1885.

A closing-dam (No. 31) is designed to extend from Oyster Bed Shoal, northwest of Fort Pulaski, to Turtle Island, through the deeper portions of which gap very strong ebb currents divert the water to the detriment of the channel selected for improvement, south of Oyster Bed Shoal. The work was seriously injured by the cyclone of August, 1885, and but partially repaired.

It is estimated that from December, 1878, when work on the dams was commenced, to June 30, 1886, the following quantities of material have entered into the construction of wing-dams, closing-dams, and jetties:

Log and brush mattresses, averaging 18 inches in thickness	square yards	292,153
Brush-wood fascines and brush-wood mattresses	cubic yards	22,267
Riprap stone	do	64,631

Dredging.—More or less dredging has been done in every year since 1874 at points of the river extending from the vicinity of Cross Tides to Tybee Knoll, northeast of Fort Pulaski. The material removed by dredging amounted on June 30, 1886, to 1,736,542 cubic yards.

For further details regarding the work done in former years, attention is invited to my annual report of operations for the fiscal year ending June 30, 1886, and to preceding annual reports.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

An appropriation of $150,000 having been made by act approved August 5, 1886, operations were resumed in November of that year, and practically suspended at the close of the fiscal year, all the available funds being then exhausted.

The work done consisted in extending the Fig Island Jetty downstream, building new wing-dams in the lower part of the river, repairing dams injured by the cyclone of August 25 and 26, 1885, raising two closing-dams below Elba Island to a greater height, and in dredging at various points of the river.

Proposals for the construction of training-walls and wing-dams in Savannah Harbor and River, and proposals for dredging where required, between Cross Tides and Tybee Roads, were invited September 11, 1886. The specifications for work on the dams were in all essential features identical with those described in detail in my annual report for the fiscal year ending June 30, 1885.

Of the bids received for work on dams, that of Mr. John F. Gaynor was the lowest, and a contract was made with him October 28, 1886. Soon after resuming operations it was found that the damage to the upper courses of some of the dams, caused by the cyclone of August, 1885, had left their crests so irregular and uneven, as to render it impracticable to repair and raise them with the somewhat rigid log mattresses provided for in the specifications; and by authority of the Secretary of War a supplemental contract was entered into with Mr. Gaynor, requiring brush-wood fascines, singly or in mattresses, as might be needed, to fill gaps and to level off the injured dams to a height of from 3 to 5 feet above low water. One dollar and ten cents was paid per cubic yard of fascines placed in the work.

Mr. Gaynor was also the lowest bidder for the dredging, and the contract was awarded to him.

WORK ON DAMS.

Fig Island Jetty or Training-wall.—This work had, in August, 1885, been completed up to the level of about 5 feet above mean low water. By the cyclone at the end of that month portions of the jetty were damaged; at other points the crest was lowered by the tearing out by unknown parties of stone and brush to make room for the passage of small boats.

At the beginning of operations of the past fiscal year the average height of the crest above mean low water was about 3 feet. With a view of better conserving the ebb currents in the channel at "The Wrecks" the jetty was raised during the latter part of the fiscal year to the level of mean high water, using brush-fascines and stone to the height of 5 feet above low water, and stone alone for the portion higher up, making the stone-work 5 feet wide at the high-water line.

As stated in my last annual report, some shoaling had been observed at the lower end of "Wrecks" Channel, beyond the down-stream end of Fig Island Jetty, and to remedy that defect an extension of the jetty was proposed. It has accordingly been extended 750 feet farther downstream; its extreme end rests in 18 feet water at low tide. The greater part of the extension is formed of eight courses of log matresses loaded with riprap stone; the mattresses vary in width from 40 feet at the bottom to 15 feet for the two upper courses. The crest is at the level of mean high water, and is formed of stone alone, like that of the older part of the jetty above described.

Long Island Crossing—A pair of wing-dams, numbered 28 and 35, were built in conformity to the existing project at the lower end of this crossing, where considerable shoaling had taken place. Dam 35 has no shore end, properly speaking; it begins at a point 500 feet from the south shore of Jones's Island, near its lower end. This gap was left because the water is here very shallow, and there seemed to be no necessity of incurring the expense of filling it up at present. From the starting point the dam extends about 2,400 feet in a southerly direction, terminating in a toe, formed of a mattress 60 feet wide and 50 feet long. The outer 1,500 feet length of the dam, nearest to the navigable channel, rises to a height of 5 feet above mean low water; for the inner 500 feet length only the foundation has been laid, while the intermediate section has been built up to the low-water line. The foundation mattresses are 40 feet wide.

Dam 28, opposite Dam 35, starts from a point near the middle of the north shore of Long Island; its length is 305 feet. At the shore end its crest rises to the level of high water; at the channel end it is about 2 feet lower. Between the heads or channel ends of the two dams the width of the water-way is 1,350 feet; the natural width of the river at the site of these dams is about 4,500 feet.

Repairs to wing-dams and closing-dams.—Slight repairs were made to wing-dam 25, at the Upper Flats. Wing-dam 14, Lower Flats, originally finished in January, 1885, and injured by the cyclone of August of that year, was repaired with brush-fascines and riprap stone, and its crest leveled off at the height of 5 feet above mean low water. Wing-dams 26 and 33, which suffered severely from the cyclone, were repaired, and had their tops leveled off in the same manner as No. 14.

Two closing-dams below Elba Island, known as Philbrick's Cut Dam and Big Gap Dam, had been damaged by fishermen, who persisted in removing stone from the work to open small passage-ways for their boats. It was found impossible to keep these dams in proper order unless they were brought up to high-water level. This was accordingly done, finishing off the upper portion solidly with stone, on a width of 6 feet at the top.

The 40,980.5 square yards of log and brush mattresses, 39,053.5 cubic yards of brush-wood fascines, and 17,241.75 cubic yards of riprap stone were expended in the operations of the fiscal year.

DREDGING.

Dredging was done at the following-named places:

Places.	Material removed.
	Cubic yards.
Vicinity of Central Railroad Wharf, Savannah City	8, 623
Vicinity of Upper Rice Mill, Savannah City	12, 817
Foot of West Broad street, Savannah City	3, 273
Garden Bank Shoal, Savannah City	24, 833
Channel at "The Wrecks"	41, 844
Channel at Upper Flats	4, 418
Channel at Tybee Knoll, northeast of Fort Pulaski	25, 286
Total	121, 093

The dredging operations were commenced November 1, 1886, and suspended May 28, 1887.

CONDITION OF THE IMPROVEMENT.

Cross Tides.—The dam at Cross Tides has settled slightly near its middle, otherwise no change has taken place since my last annual report.

In front of Savannah City.—Some shoaling having occurred in the vicinity of Upper Rice Mill, a channel of 2,520 feet length, 60 feet width, and 15 feet mean low-water depth was dredged, and retained these dimensions at the close of the fiscal year. Shoaling in the channel at Garden Bank Shoal, mentioned in my last report, having continued, a good navigable channel of nearly 15 feet depth at low tide was dredged. Washing of sand from the streets of the city, referred to by me on several occasions, is still going on, and will be the cause of renewed shoaling at this place and at other points in front of the city. The wing-dams are in good order.

Channel at "The Wrecks."—The Fig Island training-wall is in good condition. Silt is accumulating between its spurs as desired, and the growth of marsh grass on the shoal is progressing favorably. The least available low-water depth in the channel is at present 14.2 feet.

Channel at "The Obstructions."—Wing-dam No. 15, opposite the head of Elba Island, is in good condition. Between the upper and lower 15-foot low-water curves the least low-water depth is 13.4 feet, a shoaling of half a foot during the year. It is evident that the south channel of Savannah River absorbs too much of the ebb flow, and, as originally contemplated, must be further obstructed or entirely closed.

Upper flats.—The wing-dams built for regulating this reach are in good condition. The channel has generally the required depth, except between and near the lower pair of wing-dams (Nos. 10 and 27), where the least available low-water depth is at present 14.1 feet.

Lower flats.—The dams built at this crossing are in good condition. The upper and lower 15-foot low-water curves are separated by a shoal of 2,200 feet length with a minimum low-water depth of 13.4. Additional works for contracting the river at this place are necessary.

Long Island Crossing.—Wing-dams Nos. 26 and 33, injured by the cyclone of 1885, were repaired, and they as well as the new pair of wing-dams (Nos. 28 and 35) are in good order. The practicable low-water depth in the channel is very nearly 14 feet.

Mouth of river.—The logs and stone of Dam No. 31 at Oyster Bed Shoal form now a compact mass, due to the abundant growth of oyster shells upon them, but where logs are exposed to the teredo they are badly damaged. The channel at Oyster Bed Shoal has been well maintained throughout the year by natural scour alone. Its least navigable depth is nearly 16 feet at mean low tide.

The dredging done in Tybee Knoll Channel during the past fiscal year has only temporarily improved its depth. At the end of the year it had again been reduced to 13.4 feet at mean low water. This indicates that the training-wall contemplated in the project of January 16, 1882, for improving this reach will have to be constructed.

Closing dams.—The dams at Philbrick's Cut and Big Gap, recently built up to the level of high water, are in good condition. The other works of this class, described in former annual reports, have settled at some points, but they continue in serviceable order.

REMARKS ON THE COMMERCE AND NAVIGATION OF SAVANNAH HARBOR, AND THE PROBABLE EFFECTS OF THE IMPROVEMENT OF THE RIVER IN RELATION THERETO.

The work of improvement in conformity to the approved project was commenced in 1874. With a view of facilitating a comparison of commercial statistics for that year, and for the year 1886, they have been consolidated as follows:

COMMERCIAL STATISTICS OF THE PORT OF SAVANNAH, GEORGIA.

Arrivals and clearances of vessels, tonnage, etc.

ARRIVED.

	1874.			1886.		
	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.
Coastwise	418	354,700	10,048	393	503,073	14,534
Foreign ports:						
American vessels	66	41,030	847	10	5,952	185
Foreign vessels	284	182,517	4,232	268	177,229	3,719
Total	768	578,247	15,127	671	686,254	18,438

CLEARED.

	1874.			1886.		
	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.
Coastwise	480	407,295	12,748	378	473,135	13,912
Foreign ports:						
American vessels	71	40,397	822	3	939	24
Foreign vessels	229	145,038	3,437	262	194,793	3,970
Total	780	592,730	17,007	643	668,867	17,906

It appears from this that while in 1886 the number of vessels arrived and cleared was 15 per cent. less than in 1874, the aggregate tonnage in 1886 was about 16 per cent. larger. The average tonnage of vessels in 1874 was about 750; in 1886, over 1,000.

The following tables show the values of the principal articles of export and import in the years ending August 31, 1874, and August 31, 1886, respectively:

EXPORTS.

	1874.	1886.
Cotton, upland and sea-island	$47,774,638	$38,807,726
Timber and lumber	667,189	1,010,580
Naval stores	59,029	3,296,503
Rice	531,796	210,307
Pig-iron	51,500	193,835
Hides and wool	190,296	212,304
Fruits and vegetables	451,680	1,834,713
Yarns and domestics	2,897,315	3,314,950
Miscellaneous	1,638,200	2,127,212
Total exports	54,261,553	51,028,190

IMPORTS.

	1874.	1886.
Fertilizers	$1,338,509	$2,238,654
Coal	170,325	224,340
Hay and grain	408,975	318,250
Salt	80,000	126,000
Coffee	275,000	512,000
Miscellaneous	35,890,525	47,699,280
Total imports	38,370,525	51,118,524

The above statement does not include receipts and shipments by rail, nor does it include the value of domestic traffic, local manufactures, banking, etc., but is confined strictly to value of exports and imports, which have a direct bearing upon the water-ways transportation of the city of Savannah. While values have decreased during the past fifteen years about one-third, the values in 1886, compared with 1872 in volume, are nearly 50 per cent. greater. This is due to the large increase in tonnage. The item of miscellaneous in imports embraces bagging, iron ties, tobacco, cigars, boots and shoes, dry goods, hats, clothing, furniture, hardware, crockery, flour, bacon, sugar, canned goods, and manufactured articles generally.

The shrinkage of values referred to is illustrated in the case of the main staple, cotton, as shown by the following table:

Exports of upland and Sea Island cotton from the port of Savannah, Ga., and values per bale.

Year ending August 31—	Exports, foreign.		Exports, coastwise.		Value per bale.		Total export.	Total values.
	Upland.	Sea Island.	Upland.	Sea Island.	Upland.	Sea Island.		
	Bales.	*Bales.*	*Bales.*	*Bales.*			*Bales.*	
74	426,099	3,472	222,073	4,489	$72.50	$98.25	656,133	$47,774,638
86	400,437	1,483	383,316	21,307	47.00	86.50	806,543	38,807,726

If the prices paid for both kinds of cotton in 1874 had prevailed in 1886, the total value of cotton exports in the latter year would have been $59,061,310 instead of $38,807,726.

The exports of timber were, in 1874, 37,898,599 feet, valued at $667,189; in 1886 they were 76,753,746 feet, valued at $1,010,580; the value would have been $1,351,217 if the same prices had ruled as in 1874.

Savannah is at present the first naval-stores port in the world. The development of the city's export trade of naval stores has been remarkable. This business was insignificant some fifteen years ago. In 1874 the shipments of rosin were 18,200 barrels, valued at $59,029. From that year there has been a progressive increase, culminating in 1886, when the highest figure yet attained was reached. In 1886 the shipments, foreign and coastwise, were 135,498 barrels of spirits of turpentine and 605,257 barrels of rosin, of an aggregate value of $3,296,503.

It is generally conceded that the improvement of Savannah Harbor and River by the United States Government has been an important factor in the reduction of rates of freight and insurance that has taken place in the latter years, and of the rates of competing routes of transportation, but it would be impossible to state precisely what part of the amount of reduction is due to the deepening and straightening of the ship-channel from Tybee Roads to the city of Savannah, and what part to other causes. As stated in my annual report for the fiscal year ending June 30, 1886, several vessels of over 20 feet draught passed during the year from the sea to the city, and *vice versa*, on a single tide, something never before accomplished. Within the last five or six years the available depth in the navigable channel has increased 3 to 3½ feet. This fact would manifestly account for a reduction of rates of freight and insurance.

Considering the favorable results already obtained, I feel no doubt that the completion of the proposed improvement will be highly advantageous to commerce, and to the large section of the country of which

Savannah is the principal shipping port. The plan of improvement contemplates the establishment of a navigable channel of 22 feet depth from the bar to the city of Savannah. With that depth obtained—and it probably will be at a cost not exceeding the estimate—the advantage of still lower rates of freight and insurance will be secured and a greater impetus will be given to agricultural and industrial production over a large area of country naturally tributary to the port of Savannah, resulting in an increased demand for and employment of skilled and unskilled labor, and in benefits to the public generally, which follow a substantial increase in transportation facilities.

I earnestly recommend that the funds needed for completing the project of improvement may be provided as soon as possible. When the works are once finished a moderate annual allotment for making repairs and for doing some dredging here and there will be required; for which purpose a sum of about $20,000 per annum will probably be sufficient.

The river and harbor act of August 5, 1886, also provided that an examination and survey should be made of "Savannah River from Cross Tides, above Savannah, to the bar, with a view to obtaining 28 feet of water in the channel." A preliminary examination was accordingly made, and my report of it forwarded to the Department under date of November 29, 1886. A survey was then ordered, which was commenced toward the close of the past fiscal year and is now approaching completion. I regret to say that the amount of funds allotted for the survey is not sufficient to carry it on upon a scale commensurate with the importance of the object in view. The survey will furnish data for a preliminary project, subject to future amendments and modifications; but a more liberal allotment ought to be made at the earliest opportunity, which will enable me to initiate and carry out a system of investigations concerning the progress of the tidal wave, direction and strength of currents, volumes of discharge, and many other matters which must be known before a well-digested project can be prepared for improving the navigation of the river on the scale proposed. I would further say, that if such an enlarged plan of improving Savannah Harbor and River is finally adopted, the appropriations should be made annually and in amounts proportionate to a work of such magnitude.

The work of improvement has now reached a point where, in the interests of economy, operations should be conducted throughout the whole extent of the river simultaneously, and if any funds are appropriated during the present fiscal year the amount should be sufficient to begin work under the project for obtaining 28 feet of water from the city to the sea. In addition to the $180,000 required for the completion of the existing project, I would earnestly recommend that not less than $600,000 be appropriated for beginning work under the new project.

This work is located in the collection district of Savannah, Ga., at the port of entry. Amount of duties collected in 1886, $35,455.33.

Since the works of improvement were commenced, the following appropriations have been made:

By act of Congress approved June 23, 1874	$50,000
By act of Congress approved Mar. 3, 1875	70,000
By act of Congress approved Aug. 14, 1876	62,000
By act of Congress approved June 18, 1878	70,000
By act of Congress approved Mar. 1, 1879	100,000
By act of Congress approved June 14, 1880	65,000
By act of Congress approved Mar. 3, 1881	65,000
By act of Congress passed Aug. 2, 1882	200,000
By act of Congress approved July 5, 1884	200,000
By act of Congress approved Aug. 5, 1886	150,000
Total	1,032,000

The total expenditures to June 30, 1887, were $1,028,353.81. To complete the work of improving Savannah Harbor and River, Georgia, in accordance with the approved project of January 16, 1882, there will be required the additional sum of $180,000.

The following drawings and papers are transmitted herewith:

(1) *Sheet* 1.—Chart showing works constructed for the improvement of Wreck's Channel, to June 30, 1887.

(2) *Sheet* 2.—Chart showing works constructed for the improvement of Long Island Crossing, to June 30, 1887.

(3) Report of First Lieut. A. M. Carter, Corps of Engineers.

(4) Table of commercial statistics furnished by the collector of the port.

(5) Table showing value in dollars of exports and imports, foreign and domestic, at port of Savannah, from 1872 to 1886. Compiled by E. F. Bryan, superintendent Savannah Cotton Exchange.

(6) *Money statement.*

July 1, 1886, amount available	$2,943.90	
Amount appropriated by act approved August 5, 1886	150,000.00	
		$152,943.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	115,410.31	
July 1, 1887, outstanding liabilities	33,887.40	
		149,297.71
July 1, 1887, amount available		3,646.19

Amount (estimated) required for completion of existing project, and beginning work under the new project	780,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	780,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for construction of wing-dams, etc., in Savannah Harbor and River, Georgia, opened September 30, 1886.

No.	Name of bidder.	Mattresses per square yard.	Stone per cubic yard.	Aggregate cost of the work.
1	P. Sanford Ross	$0.52⅛	$2.75	$101,250
2	John F. Gaynor	.38	3.00	96,000
3	Rittenhouse Moore	.43	2.90	97,500
4	Anson M. Bangs	.43	2.90	97,500

Contract awarded to John F. Gaynor at the prices stated.

Abstract of proposals for dredging in Savannah Harbor and River, Georgia, opened September 30, 1886.

No.	Name of bidder.	Price per cubic yard.
		Cents.
1	P. Sanford Ross	23.8
2	Rittenhouse Moore	24.7
3	Morris & Cumings Dredging Company	25.75
4	John F. Gaynor	19
5	American Dredging Company	25
6	Savannah Dredging Company	25

Contract awarded to John F. Gaynor at price stated.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 11, 1887.

COLONEL: I have the honor to submit the following report of operations for improving the harbor at Savannah, Ga., during the fiscal year ending June 30, 1887:

The work, all of which was done under contract with Mr. John F. Gaynor, of Fayetteville, N. Y., consisted in constructing wing-dams and training-walls of log and brush mattresses, loaded with riprap stone, and in dredging. In raising and repairing old dams it was found impracticable to use the ordinary log and brush mattresses to advantage, and brush fascines were substituted. Dredging was begun on November 1, 1886, and suspended on May 28, 1887.

Jetty work was begun on November 28, 1886, and suspended, on account of lack of funds, on July 3, 1887.

CROSS TIDES DAM.

No work was done on this dam during the year, and with the exception of some slight settlement near its middle its crest remains about as described in my last annual report.

UPPER RICE MILL.

Some shoaling took place in this vicinity during the year, and a channel 2,520 feet long, 60 feet wide, and 15 feet deep at mean low water was dredged between the ocean steam-ship wharves and the foot of West Broad street. In the execution of this work numerous raft binders, logs, snags, old anchors, and other obstructions were removed from the channel. There is now a good navigable channel across this shoal, with a least mean low-water depth of 15.1 feet, a deepening of 1.1 feet since last year.

GARDEN BANK SHOAL.

The wing-dams at this point are in good condition. The shoaling mentioned in my report of last year continuing and navigation being much obstructed, 24,833.5 cubic yards were dredged from the channel in this vicinity during the year. There is now a good navigable channel here with a least mean low-water depth of 14.9 feet, a deepening of 2 feet since last year. The washing of sand from the city streets continues, and some future shoaling from this cause is to be expected.

WRECKS CHANNEL.

The shoaling below the lower end of the Fig Island training-wall continuing, an extension of 750 feet was built during the year. To better direct the ebb currents in this channel the crest of the Fig Island training-wall was brought up to mean high water throughout its entire length. The spurs were brought up to mean high water at their junction with the jetty, sloping down from that point to mean low water at their outer ends. The work was done with brush fascines, loaded with riprap stone.

The silting up between the spurs and the extension of the growth of marsh grass along this shoal continue.

Forty-one thousand eight hundred and forty-three cubic yards were dredged from this channel during the year.

The least mean low-water depth is now 14.2 feet.

OBSTRUCTIONS.

No work was done here during the year. Wing-dam No. 15 is in good condition. The 15-foot mean low-water curves above and below this point are separated from each other by a shoal 650 feet in length, over which there is a least mean low-water depth of 13.4 feet; a shoaling of half a foot since last year's report. As stated in previous reports, this shoal can not be permanently removed until the south channel is closed.

UPPER FLATS.

Wing-dams Nos. 4, 6, 10, 23, and 27 are in good condition and have not changed since last year's report. A small gap in dam No. 25 was filled with brush fascines and stone. This dam is now in good condition.

The channel depths at the upper end of this crossing have been maintained and the width between the 15-foot mean low-water curves has increased during the year. Some shoaling occurred at the lower end of the reach between dams Nos. 10 and 27, and a channel 780 feet long, 60 feet wide, and 15 feet deep at mean low water was dredged there in December.

There is now a good navigable channel across this shoal, with a least mean low-water depth of 14.1 feet.

LOWER FLATS.

Wing-dams Nos. 14 and 29, which were slightly injured in the cyclone of 1885, were repaired and are now in good condition. No other work was done here during the year. The 15-foot mean low-water curves above and below this crossing are now separated from each other by a shoal 2,200 feet long, upon which there is a least mean low-water channel depth of 13.4 feet. The upper curve does not extend as far downstream by 200 feet as last year and the lower curve has receded down-stream during the same period a distance of 700 feet.

Additional contraction will eventually be needed below dams Nos. 14 and 29 for the improvement of this crossing.

LONG ISLAND CROSSING.

Wing-dams Nos. 26 and 33, which had been injured by the cyclone of 1885, were repaired and brought up to 5 feet above mean low water during the year.

For the improvement of the lower portion of this reach wing-dams Nos. 28 and 35 were constructed. They reduce the low-water width of the river from 4,500 feet to 1,350 feet. Dam No. 35 was not connected with the shore, but no scour has taken place there since its construction. The channel defined by the 15-foot mean low-water curves has narrowed since my report of last year. The upper curve has pushed downstream 480 feet and the lower 1,660 feet during the year. The least mean low-water channel depth on this crossing is now 13.9 feet, which is the same as at the close of the last fiscal year

MISCELLANEOUS.

No work was done at the Oyster Beds during the year. The stone and logs on Dam No. 31 are now cemented by oyster-shells into a solid mass. The logs wherever exposed, however, are badly eaten by the teredo. The width and depth of the channel across the old shoal near that point have both increased during the year. The least mean low-water channel depth is at present 15.8 feet.

During the winter months 16,153.5 cubic yards were dredged from the channel across Tybee Knoll. The dredged depth was not maintained, and beyond the removal of a few lumps near the channel in May no further work was done there. It will be necessary to build the Oyster Bed training-walls before the channel at that point can be permanently improved. The least mean low-water channel depth across Tybee Knoll is at present 13.4 feet.

The closing-dams at Philbrick's Cut and Big Gap were brought up to mean high water during the year, and both dams are now in good condition.

The other closure-dams upon the river have settled in some cases, but have subserved their purposes and are in good order.

Beyond the general fact that the river has been deepened the information concerning the effects upon it of the improvements thus far made is very meager.

It having been decided that funds appropriated for carrying on work under an approved project can not be properly applied to any other purpose, it has been impossible to make any observations upon or any study of the physical features of the river, although the necessity for such is undoubted. Concerning the rate of progress of the tidal wave, the direction and force of the tidal currents, the discharge of the stream, the ratio of the volume voided during the flood to that voided during the ebb tide, and the effects which the improvements thus far executed have had upon the high and low water slopes of the river, very little is known. The varying influences of winds, storms, and freshets make it imperative that observations to have any value should extend over several months—better, several years—and it is earnestly recommended that authority may be granted to use yearly a small amount of the appropriations for the improvement of the river in a study of the physical features of the stream, or if this is impracticable that a special appropriation may be made for this purpose.

The tables of commercial statistics appended hereto show a steady growth of both the foreign and domestic trade of Savannah. It is now the largest port of the South Atlantic coast, the second cotton-port of America, and the first naval-stores' port of the world. The exports of cotton have risen from less than 500,000 bales in 1872 to over 800,000 bales in 1886, and are still increasing.

The increase in value of the annual exports of naval stores is still more remarkable. Starting with a value of less than $50,000 in 1873, it reached a total of over $3,250,000 in 1886, with prospects for a still greater increase in the future. The receipts of spirits of turpentine for the year 1886–'87 were nearly 40,000 casks greater than those for the corresponding period of last year, and the rosin receipts for this period were over 131,000 barrels greater. The value of the exports of timber and lumber within the past fifteen years has risen from about $500,000 to over $1,000,000; that of fruits and vegetables from less than $500,000 to nearly $2,000,000, while that of pig-iron has risen from about $25,000 to nearly $200,000.

While the volumes of exports have thus increased, and the tonnage entered at the custom-house grown from 1,074,367 tons in 1873 to 1,355,121 tons in 1886, the number of vessels entered and cleared during this period has decreased by 151, from the fact that the increased depth of water in the river allows vessels of much greater carrying capacity to visit the port than in former years. In 1873, when the works of improvement were begun, the usual high-water draught was about 14¼ feet. At present, vessels of from 20 to 21 feet draught are able to go from the city to the sea on a single tide, and foreign and coastwise steamers of great carrying capacity have largely replaced the small sail vessels which fifteen years ago carried the great bulk of Savannah's commerce.

The increased facilities for navigation have resulted greatly in reducing rates of marine freight and insurance, and this has had a direct effect upon the reduction of freights over the competing land routes. So many causes, however, have been in operation during the last fifteen years to secure reductions in these directions that it is perhaps impossible to ascertain what portion is due to the improvement of the harbor. Mr. Connor, late the president of the Savannah Cotton Exchange, estimates it at 25 per cent., and this is perhaps below rather than above the actual decrease, inasmuch as without the improvements already near completion it would be impossible for a majority of the foreign and coastwise steamers now plying to this port to enter the harbor at all.

As to the advantages, prospective and realized, through the completion of the proposed improvements, it may be stated that those already made have justified the extension of lines of railway into the interior, opening up to those places markets for their products which before did not exist.

The Savannah, Florida and Western Railway system, embracing over 750 miles of railway in Florida and Georgia, with nearly 1,000 miles of steam-boat and steam-ship lines tributary thereto, depends largely for the shipment of its freight upon the facilities afforded by the port of Savannah. Through the Central Railroad system of Georgia, with over 2,200 miles of railway in the States of Georgia, Alabama, and South Carolina, the richest timber, coal, and iron districts of those States find an outlet at Savannah to the sea. With the extensions now being constructed, the States of Mississippi, Tennessee, and Kentucky, as well as the great grain-producing sections of the West, will be brought nearer to the Atlantic coast at Savannah than at any other point, and over railways of easy grades, free from obstruction by snow and ice. With increased shipments of heavy freights, such as grain, iron, and coal, deeper water at Savannah will be imperatively required. The improvements heretofore executed and the expectations of further improvements yet to be made have been the inducements to develop the railway systems before mentioned. The sections of country made tributary to Savannah by these railways are among the richest in the United States, and to enable the port to furnish an outlet for the growing commerce brought to it from the interior, deep water is more than ever needed.

The work of improvement has now reached a point where, with irregular and insufficient appropriations, such as have been made in the past, future progress will be slow and unsatisfactory. Operations should be conducted throughout the whole extent of the river simultaneously, and dredging should be accompanied with or promptly followed by contracting works.

In carrying on operations under the project for obtaining 28 feet of water from the city to the sea the most satisfactory results can not be obtained with an expenditure of less than $1,000,000 during the next fiscal year.

Tables of commercial statistics and arrivals and clearances of vessels are appended hereto. Charts showing works constructed for the improvement of the Wrecks Channel and the Long Island Crossing are transmitted herewith.

The following tables show work done during the year:

Jetty work.

1886-'87.	Locality.	Mats.	Fascines.	Stone.
		Sq. yds.	*Cu. yds.*	*Cu. yds.*
November, December, April, June	Dam No. 28	2,587.55	160.00	516.54
December, January, February, March, April, May.	Dam No. 35	20,924.68	899.02	4,292.15
December, January, February, May, June.	Dam No. 26	1,253.65	2,372.37	1,362.51
December, January, May	Dam No. 33	227.33	1,623.33	1,054.24
February, March, April, May, June	Fig Island Jetty	15,987.24	23,271.18	7,526.10
May	Dam No. 25		217.71	87.77
June	Dam No. 14		639.16	138.84
Do	Dam No. 29		398.38	186.51
Do	Philbrick's Cut Dam		1,255.05	253.77
Do	Big Gap Dam		8,217.23	1,878.32
Total		40,980.45	39,053.43	17,241.75

Dredging.

1886-'87.	Locality.	Cubic yards.
November, December, January, February, May	Tybee Knoll	25, 286. 0
December	Upper Flats	4, 418. 5
December, January, February	Wrecks Channel	41, 843. 0
November, December, April, May	Garden Bank	24, 833. 5
February, March, April	Upper Rice Mill	24, 712. 0
Total		121, 093. 0

Mr. R. G. Thomas, assistant engineer, has performed his duties during the year with skill and fidelity.

Very respectfully, your obedient servant,

O. M. Carter,
First Lieutenant, Corps of Engineers.

Col. Q. A. Gillmore,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Savannah, Ga., from January 1, 1873 *to December* 31, 1886.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.			Greatest draught.*
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	*Feet.*
1873	463	381, 595	11, 934	34	16, 140	383	213	119, 316	2, 999	710	517, 051	15, 316	17. 50
1874	418	354, 700	10, 048	66	41, 030	847	284	182, 517	4, 232	768	578, 247	15, 127	17. 50
1875	370	310, 877	10, 102	67	39, 298	781	222	145, 748	3, 290	659	495, 923	14, 173	17. 50
1876	355	320, 015	10, 348	58	40, 832	987	260	169, 649	3, 865	673	530, 496	15, 200	17. 75
1877	333	379, 826	10, 867	54	40, 948	951	287	168, 247	3, 950	674	589, 021	15, 768	18. 25
1878	322	385, 532	10, 688	61	45, 208	1, 576	326	235, 787	5, 814	709	666, 527	18, 078	18. 50
1879	319	411, 794	8, 235	30	21, 994	439	279	198, 040	3, 960	628	631, 828	12, 634	17. 75
1880	338	446, 881	9, 996	14	7, 724	170	244	172, 224	3, 533	596	626, 829	13, 699	18. 33
1881	383	508, 422	11, 069	21	10, 729	237	254	151, 463	3, 474	658	670, 614	14, 780	19. 00
1882	391	544, 448	12, 605	11	4, 865	106	204	115, 061	2, 718	606	664, 374	15, 429	19. 00
1883	380	468, 226	10, 659	10	4, 115	90	160	87, 025	1, 965	550	559, 366	12, 714	18. 25
1884	388	482, 917	13, 735	14	5, 632	116	287	174, 676	3, 984	689	663, 225	17, 835	19. 00
1885	396	493, 610	14, 622	12	5, 058	125	251	163, 321	3, 416	658	661, 989	18, 163	20. 75
1886	393	503, 073	14, 534	10	5, 952	185	268	177, 229	3, 719	671	686, 254	18, 438	20. 00

CLEARED.

Years.	Coastwise.			Foreign ports.						Total.			Greatest draught.*
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	*Feet.*
1873	466	398, 050	13, 749	65	30, 102	689	224	129, 164	3, 194	755	557, 316	17, 632	17. 50
1874	480	407, 295	12, 748	71	40, 397	822	229	145, 038	3, 437	780	592, 730	17, 007	17. 50
1875	319	284, 831	9, 376	72	39, 311	804	195	128, 086	2, 924	586	452, 228	13, 104	17. 50
1876	410	361, 999	11, 222	80	49, 483	1, 163	185	119, 699	2, 827	675	531, 181	15, 212	17. 75
1877	400	439, 370	12, 081	65	44, 829	1, 066	161	103, 342	2, 589	626	587, 541	15, 736	18. 25
1878	378	418, 958	10, 475	64	40, 128	1, 255	260	183, 757	5, 375	702	642, 843	17, 105	18. 50
1879	365	442, 734	8, 834	36	24, 891	497	223	156, 470	3, 129	624	624, 095	12, 460	17. 75
1880	310	434, 864	10, 108	26	12, 536	271	242	168, 255	3, 446	578	615, 655	13, 825	18. 33
1881	369	508, 422	11, 458	22	13, 052	253	261	180, 579	3, 745	652	702, 053	15, 456	19. 00
1882	350	506, 213	11, 917	23	9, 155	205	209	135, 375	3, 023	582	650, 743	15, 145	19. 00
1883	357	415, 720	9, 780	10	4, 115	90	163	87, 400	2, 015	530	507, 235	11, 885	18. 25
1884	360	452, 802	13, 363	15	5, 634	131	288	194, 075	4, 315	663	652, 511	17, 809	19. 00
1885	414	502, 773	14, 672	20	8, 722	148	228	154, 858	3, 344	662	666, 353	18, 164	20. 17
1886	378	473, 135	13, 912	3	939	24	262	194, 793	3, 970	643	668, 867	17, 906	20. 00

* Compiled by the harbor-master.

Arrivals and clearances of vessels and commerce of Savannah, Gai, etc.—Continued.

COMMERCE.

Years.	Value of exports.	Value of imports.	Duties collected.	Years.	Value of exports.	Value of imports.	Duties collected.
1873	$29, 850, 275. 00	$890, 664. 00	$160, 011. 77	1880	$49, 297, 981. 25	$660, 974. 00	$78, 458. 41
1874	50, 500, 945. 94	788, 220. 00	110, 492. 74	1881	47, 448, 117. 00	952, 512. 00	356, 550. 22
1875	46, 004, 295. 60	511, 818. 60	61, 625. 44	1882	48, 349, 033. 00	657, 255. 00	61, 148. 70
1876	41, 236, 581. 00	511, 528. 00	58, 163. 36	1883	50, 890, 937. 00	567, 182. 00	65, 245. 34
1877	33, 569, 981. 00	564, 937. 00	34, 959. 93	1884	50, 934, 184. 00	696, 434. 00	49, 147. 28
1878	41, 793, 477. 71	505, 596. 00	23, 364. 35	1885	42, 253, 397. 00	513, 286. 00	45, 162. 40
1879	44, 980, 070. 89	378, 782. 00	27, 778. 73	1886	64, 724, 275. 44	355, 433. 00	35, 455. 58

JOHN F. WHEATON,
Collector.

Value in dollars of exports and imports, domestic and foreign, at port of Savannah, Ga., through the medium of ocean transportation, from 1872 *to* 1886.

[Compiled by E. F. Bryan, superintendent Savannah Cotton Exchange, from the records of the Savannah Cotton Exchange, Savannah Board of Trade, and reports of the agents of the several steamship lines plying between this and Northern and Eastern ports.]

[Year ending August 31.]

	1886.	1885.	1884.	1883.	1882.
EXPORTS.					
Cotton	$38, 807, 726	$36, 191, 441	$33, 221, 875	$41, 773, 265	$40, 495, 221
Naval stores	3, 296, 503	2, 944, 326	3, 278, 296	2, 821, 106	2, 065, 848
Lumber and timber	1, 010, 580	924, 535	924, 454	949, 031	1, 047, 524
Rice	210, 367	344, 232	855, 937	582, 624	914, 905
Pig iron	193, 835	186, 504	175, 612	173, 560	145, 900
Hides and wool	212, 304	228, 606	215, 314	254, 296	241, 660
Fruits and vegetables	1, 834, 713	1, 767, 852	1, 790, 210	1, 512, 302	1, 460, 205
Yarns and domestics	3, 334, 950	3, 500, 620	3, 757, 311	3, 860, 450	3, 625, 460
Miscellaneous	2, 127, 212	2, 225, 100	2, 206, 504	1, 989, 300	2, 007, 525
Total exports	51, 028, 190	48, 313, 216	46, 425, 513	53, 915, 934	52, 004, 248
IMPORTS.					
Fertilizers	2, 238, 654	2, 709, 511	1, 626, 601	2, 270, 455	2, 370, 985
Coal	224, 340	196, 870	201, 200	210, 015	219, 650
Hay and grain	318, 250	350, 419	346, 550	333, 476	360, 525
Salts	126, 000	125, 000	125, 000	125, 000	125, 000
Coffee	512, 000	500, 000	500, 000	500, 000	500, 000
Miscellaneous	47, 699, 280	45, 999, 280	46, 312, 965	44, 260, 850	42, 375, 945
Total imports	51, 118, 524	49, 881, 080	49, 112, 316	47, 699, 796	45, 952, 105
Grand total exports and imports	102, 146, 714	98, 194, 296	95, 537, 829	101, 615, 730	97, 956, 353

	1881.	1880.	1879.	1878.	1877.
EXPORTS.					
Cotton	$48, 019, 799	$38, 233, 425	$32, 525, 777	$31, 993, 123	$25, 691, 547
Naval stores	2, 072, 291	1, 294, 833	908, 682	774, 207	577, 988
Lumber and timber	835, 176	853, 081	669, 064	772, 057	671, 863
Rice	879, 480	877, 248	685, 728	581, 436	465, 990
Pig iron	158, 760	133, 312	125, 200	106, 210	95, 300
Hides and wool	225, 390	240, 700	240, 915	228, 656	206, 550
Fruits and vegetables	1, 200, 150	1, 140, 625	890, 220	847, 512	628, 005
Yarns and domestics	3, 729, 605	3, 312, 412	2, 998, 510	2, 912, 367	2, 166, 400
Miscellaneous	1, 865, 250	1, 750, 775	1, 767, 325	1, 813, 420	1, 600, 210
Total exports	58, 985, 901	47, 836, 411	40, 901, 421	39, 978, 988	32, 103, 853

Value in dollars of exports and imports, domestic and foreign, etc.—Continued.

	1881.	1880.	1879.	1878.	1877.
IMPORTS.					
Fertilizers	$2, 870, 545	$3, 838, 058	$2, 784, 667	$3, 116, 788	$2, 715, 728
Coal	200, 440	198, 360	209 840	187, 350	190, 525
Hay and grain	385, 415	395, 212	360, 555	382. 012	400, 880
Salts	100, 000	100, 000	100, 000	100, 000	100, 000
Coffee	400, 000	400, 000	400, 000	400, 000	400, 000
Miscellaneous	44, 760, 500	40, 590, 850	39, 209, 410	38, 762, 315	32, 500, 775
Total imports	48, 716, 900	45, 522, 480	43, 064, 472	42, 948, 465	36, 307, 908
Grand total exports and imports	107, 702, 801	93, 358, 891	83, 965, 893	82, 927, 453	68, 411, 761

	1876.	1875.	1874.	1873.	1872.
EXPORTS.					
Cotton	$32, 817, 572	$44, 005, 476	$47, 774, 638	$61, 314, 818	$34, 266, 847
Naval stores	208, 176	110, 964	59, 029	45, 144	....
Lumber and timber	661, 562	660, 582	667, 189	562, 740	548, 895
Rice	650, 337	646, 360	531, 796	208, 250	187, 649
Pig iron	65, 250	66, 310	51, 500	40, 615	25, 500
Hides and wool	219, 400	197, 320	190, 206	175, 550	170, 410
Fruits and vegetables	512, 940	468, 500	451, 680	410, 790	492, 015
Yarns and domestics	2, 349, 672	2, 606, 450	2, 897, 315	3, 148, 167	2, 405, 960
Miscellaneous	1, 400, 555	1, 520, 320	1, 638, 200	1, 920, 325	1, 412, 440
Total exports	38, 885, 464	50, 282, 282	54, 261, 553	67, 826. 399	39, 509, 716
IMPORTS.					
Fertilizers	2, 091, 902	1, 338, 509	1, 545, 860	1, 624, 427	1, 692, 601
Coal	175, 450	182, 300	170, 325	175, 255	160, 105
Hay and grain	393, 765	406, 550	408, 975	396, 210	390, 400
Salts	80, 000	80, 000	80, 000	80. 000	80, 000
Coffee	300, 000	275, 000	275, 000	250, 000	250, 000
Miscellaneous	34, 650, 850	38, 790, 400	35, 890, 525	35, 609, 490	30, 275, 950
Total imports	37, 691, 967	41, 072, 759	38, 370, 685	38, 135, 382	32, 849, 056
Grand total exports and imports	76, 577, 431	91, 355, 041	92, 632, 238	105, 961, 781	72, 358, 772

The above statement does not include receipts and shipments by rail, nor does it include value of domestic traffic, local manufactures, banking, etc., but is confined strictly to value of exports and imports which have a direct bearing upon our water-ways transportation. While values have decreased during the past fifteen years about one-third, the values in 1886, compared with 1872 in volume, is nearly 50 per cent. greater. This is due to the large increase in tonnage. The item of miscellaneous in imports embraces bagging, iron ties, tobacco, boots and shoes, bacon, dry goods, hats, clothing, drugs, furniture, hardware, crockery, sugar, flour, cigars, canned goods, and manufactured articles generally.

N 7.

IMPROVEMENT OF SAVANNAH RIVER BETWEEN THE CITIES OF AUGUSTA AND SAVANNAH, GEORGIA.

Operations for improving Savannah River between the cities of Augusta and Savannah, Ga., have intermittently been carried on since February, 1882, by means of four appropriations made by Congress, aggregating $70,000, and of the sum of $2,500 received from other appropriations for the use of snag-boat.

An examination of this portion of Savannah River was made under my direction in September and October, 1880, and my report thereon, dated December 22, 1880, with plan of improvement, appears in Appendix J 6, Annual Report of the Chief of Engineers for 1881, and is printed in House Ex. Doc. No. 23, Forty-sixth Congress, third session.

The distance between the cities of Augusta and Savannah is about 100 miles in a straight line, and 273 miles by river.

For the greater part of the year the river was found to be navigable for steam-boats drawing from 4 to 5 feet, but during the dry season in autumn the river is very low at various places, and boats had then to discharge and receive their cargoes at some point below Augusta.

The chief obstructions to navigation were found to comprise shoals or bars of sand, snags, floating and overhanging trees, and pile obstructions.

PROJECT OF IMPROVEMENT.

The project for improving the river recommended in my report of December 22, 1880, comprises the following works:

(1) Narrowing the river by low wing-dams where excessive widths produce or maintain bars.

(2) Aiding the accumulation of silt between the wing-dams by light hurdle traverses.

(3) Protecting the banks where needed by thin, flexible brush mattresses weighted with stone, or in some other suitable manner.

(4) Cutting off projecting points of land.

(5) Removing existing pile obstructions.

(6) Removing snags, floating timber, and overhanging trees.

(7) Aiding the formation of the low-water channel in a few localities by dredging.

The object of the plan of improvement is to procure a low-river channel of not less than 5 feet, and the cost of the works is estimated at $91,000.

OPERATIONS PRIOR TO JULY 1, 1886.

With the funds first appropriated a snag-boat, designed for removing snags, piles, overhanging trees, and similar obstructions, was built. This boat has since been employed on the river reaches extending from Cooney Cut Bar, 8 miles below Augusta, to Saxon's Landing, 134 miles lower down, and a large number of snags, piles, cypress stumps, and overhanging trees have been removed, as well as the wrecks of several flat-boats. The other operations, which were carried on by contracts, comprised the improvement of the river at four places where the channel was of insufficient depth during low-river stages owing to excessive width of the water-way. These places were:

Gardner's Bar, opposite the lower part of the city of Augusta. Five wing-dams were built, their land ends resting on the left or South Carolina bank of the river. Their lengths are so adjusted as to reduce the width of the river, originally averaging 650 feet, to 350 feet. The right bank, which is steep and comparatively high, was revetted where it was caving.

Course's Bar, 1 mile below Gardner's Bar, was improved by the construction of five wing-dams, four of them resting on the left bank. These dams reduce the width of the river in the same manner as at Gardner's Bar, but the work was not completed.

At Sand Bar Ferry Bar, 4 miles below Augusta, the low-water channel was deficient in depth where it crosses from one bank to the other.

Four wing-dams were built on the left bank and one dam on the right bank with the necessary bank revetments.

At Blue House Bar the width of the water-way was reduced from 700 feet to 400 feet by the construction of four wing-dams, two on either side. The system of works required was not completed.

All these dams were formed of brushwood fascines, broken stone, and some gravel. Details of the work, briefly described above, were given in former annual reports.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

An appropriation of $15,000 was made by act approved August 5, 1886, and work was commenced in October of that year, fifteen months after the date when operations were last suspended.

As under previous appropriations, the snag-boat *Toccoa* has been employed in removing snags and other obstructions, while the construction and repair of wing-dams has been done by contract. About 40 per cent. of the appropriation was allotted to the operations of the snag-boat between the city of Savannah and Mason's Ferry, 261½ miles above.

Two hundred and fifty-nine snags, logs, and stumps, and 596 leaning trees were removed. The boat also rendered efficient assistance in raising the steamer *Ethel*, that had been snagged and sunk near Beck's Ferry, 30 miles above Savannah. Proposals for continuing the work of building and repairing wing-dams were invited November 29, 1886. Except that no gravel was to be employed for covering the brush work, the specifications were essentially the same as those which formed part of the preceding contract, details of which were given in my annual report for the fiscal year ending June 30, 1885.

Of two bids received, that of John F. Gaynor, of Savannah, Ga., was the lowest, and, with the approval of the Department, a contract was made with him February 9, 1887.

An examination made in the early part of March, 1887, had shown that it was necessary to resume work at Blue House Bar, 6 miles below Augusta, and at Course's Bar, 1½ miles below the toll-bridge at Augusta, where all the dams designed for its improvement had not yet been built.

At Blue House Bar, two new wing-dams (1 and A) were built about 360 feet above another pair (2 and 3) formerly constructed; also a new dam (3½), springing from the right (Georgia) bank of the river, lower down, between two older dams (3 and 5) on the same side. During a long continued high stage of the river in the preceding year, while operations were at a stand-still, the currents had cut behind Dams 2 and 4, on the left or South Carolina bank, leaving these dams disconnected from the new-made bank. These dams were extended to the rear, and strong bank protections constructed. Dam No. 3 opposite (No. 2), which had settled somewhat, was raised to its proper level.

At Course's Bar, where five wing-dams (7, 8, and 10 on the left bank, and 6 and 9 on the right bank) already existed, a pair of new wing-dams (11 and 12) was constructed, leaving a water-way of 480 feet between their heads, the width of the river here being about 800 feet. The older dams were raised and strengthened. These operations exhausted the available funds, and work was again suspended April 30, 1887.

The material employed for the work during the past fiscal year amounted to 2,732.8 cubic yards of fascines and 1,725.4 cubic yards of riprap stone.

CONDITION AND EFFECTS OF THE WORKS.

The dams built on the reaches from Augusta to Blue House Bar are in good condition, except that one dam (No. 5½) at the last-named place had settled a good deal when the operations of the past fiscal year were closed, but no funds could be spared to raise it. On February 17, 1887, the snag-boat was considerably damaged by the premature falling of a large tree; she was taken to Savannah for repairs, and when these had been made she was put out of commission.

The work of the snag-boat has been very useful to the navigation of the river. On the numerous reaches where she has operated, embracing nearly the entire length of the river from Savannah to Augusta, not a single accident to a boat has occurred from running foul of snags or sunken logs, while such cases were of frequent occurrence in former years.

I regret that I have to state that the low-water channel at these places where wing-dams have been constructed is not at present in a satisfactory condition.

There is less than 3 feet of water in the channel, where previously the dams had already produced a continuous depth of not less than 4 feet. I have no doubt that the deterioration of depth is in no small measure to be ascribed to the existing mode of making intermittingly insufficient appropriations. When operations have to be suspended from want of funds, the river is again left to itself; the means are not at disposal to keep the partially improved reaches under proper surveillance, which would enable the engineer in charge to note the development of effects of the work done, and other changes in the regimen of the river, and to decide what should be done at each locality to aid a favorable development of the channel or to counteract incipient deterioration from any cause. And, even if such careful watch were held, no funds would be available to make prompt repairs where freshets have injured banks or dams, or to complete the proposed system of wing-dams and bank protections at any point, where the partially finished work has failed to produce any marked or continuous improvement.

About the time when the last appropriation was made, there had been for a year past really no low water in the river, while high floods had taken place occasionally. This led to excessive cutting of banks, causing increased deposit of sediment in the stream where the required number of dams and amount of bank revetting had not been completed.

It is also found that in the reach immediately below the city of Augusta, where the worst shoals exist, the system of works must be enlarged for better concentration of current in the low-water channel, for which purpose it is proposed to apply here, and at other shoals where it may be admissible, the expedient referred to in the existing project, to wit, the construction of light-traverses or silt-catches between wing-dams.

The plan of improvement was not based upon a comprehensive survey of the river, but only upon an examination with instrumental surveys of some places, and it could not be expected that the plan would be as perfect as desirable.

When an appropriation became available a local survey was made of such place or places where an improvement was urgently needed and might possibly be done with the funds allotted, but it was impossible, for want of sufficient means, to make a thorough survey of the whole length of river where objectionable shoals existed and where obstructions might be forming.

From data supplied by the examination it was estimated in my plan for improving Savannah River that 2,000 snags, trees, logs, and similar obstructions would have to be taken from the river between the cities of Savannah and Augusta. The snag-boat has already removed 1,996 of such obstructions, besides a number of wrecked flat-boats, and additional snagging work is still required. The irregular appropriations have necessitated working the snag boat at seasons when the river was high and when work could not be economically done, and, again, the boat had to be tied up from lack of funds for months at a time in a climate where decay is rapid. As a result, numerous and costly repairs have had to be made which would not have been needed if the boat could have remained in commission.

I am confident the general plan adopted for improving Savannah River, if carried out, will eventually secure a navigable channel of not less than 5 feet depth at low-river stages, but, for reasons just given, the original estimate of $91,000 must be increased. A more extended system of wing-dam and bank protections is required for Gardner's and Course's bars, just below the city of Augusta, where the bars must be treated as one continuous shoal, and the shoals of Sand Bar Ferry Bar and Blue House Bar need additional work. No work has yet been done at the deficient reaches of Cooney Cut Bar, Tutt's Shoal, the two Twigg's Bar, Flowery Gap Bar, Brigham Bar, and some other places of lesser importance. I think that the original estimate must be increased about $85,000, including the cost of additional work to be performed by the snag-boat *Toccoa.*

With any funds that may be provided by Congress it is contemplated to complete the systems of works already commenced at Gardner's Bar, Course's Bar, Sand Bar Ferry Bar, and Blue House Bar, and at places lower down, or so much of the work indicated as the amount of the appropriation may permit.

REMARKS ON COMMERCE AND NAVIGATION OF SAVANNAH RIVER BELOW AUGUSTA.

The information received by me in regard to the commerce and navigation of Savannah River, in the year 1882, when the work of improvement was commenced, and at the present time, is rather meager.

It is understood that in 1882 the commerce of the river, especially in the way of through shipments, was unimportant, as the condition of the channel rendered navigation uncertain and unsafe. Partially as a result of the improvement thus far effected, the total freight that passed over the river at Augusta during the year ended June 1, 1887, is stated to have been 10,488 tons, the bulk of which—6,643 tons—was through freight down-stream, including 6,158 tons (or 25,911 bales) of cotton, and 427 tons naval stores. A considerable business is said to be carried on by steamboats which do not run up as far as Augusta. Some details of the present commerce of the river are given in the accompanying report of my assistant, First Lieut. F. V. Abbot, Corps of Engineers.

The work thus far done by Government has enabled the boats plying between Augusta and Savannah to carry goods at a reduced cost of at least 20 per cent. in freight on merchandise and one-eighth cent per pound on cotton. As regards insurance, the difference in rates between the river and competing railroads is considered to be insignificant. Augusta is a rapidly growing city; according to the census of 1880, its population was then 23,023; it is now said to contain between 35,000 and 40,000 inhabitants.

The completion of the proposed improvement of Savannah River, establishing a navigable channel of 4½ to 5 feet water at low stages, would probably be followed by a reduction of the freight rates on cotton of about 50 cents per bale, and 20 per cent. on all eastern freights.

Augusta would become an important distributing point for large portions of Georgia and South Carolina, and to some extent for Alabama, thereby benefitting the population of such tributary country, permitting them to send their staple products, chiefly cotton, at reduced expense to port, and receiving at less cost their merchandise, fertilizers, etc., from the Eastern States and the West Indies. A permanently improved navigation of the river will necessarily compel the competing railroads to reduce their rates accordingly.

It is desirable that Congress should make a liberal appropriation to carry on operations vigorously.

This improvement is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collected in 1886, $35,455.53.

Since the plan of improvement was adopted, the following appropriations have been made:

By act of Congress approved March 3, 1881	$15,000
By act of Congress passed August 2, 1882	25,000
By act of Congress approved July 5, 1884	15,000
By act of Congress approved August 5, 1886	15,000
	70 000
Received from other appropriations for use of snag-boat	2,500
Total	72 500

Of this amount the sum of $72,345.08 has been expended to June 30, 1887.

The total cost of the existing project was estimated at $91,000. For reasons stated in this report, this estimate will have to be increased by $85,000, making the probable ultimate cost of the improvement $176,000.

The reports of First Lieut. F. V. Abbot and First Lieut. O. M. Carter, Corps of Engineers, are transmitted herewith.

Money statement.

July 1, 1886, amount available		$235.15
Amount appropriated by act approved August 5, 1886		15,000.00
		15,235.15
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$14,730.47	
July 1, 1887, outstanding liablities	349.76	
		15,080.23
July 1, 1887, amount available		154.92

Amount (estimated) required for completion of existing project	21,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	21,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for building and repairing wing-dams, etc., in Savannah River, below Augusta, Ga., opened December 29, 1886.

No.	Names of bidders.	Mattresses, per square yard.	Stone, per cubic yard.	Agregate cost of the work.
1	John F. Gaynor	$1.27	$2.57	$8,640.00
2	Albert J. Triggs	.75	3.50	9,562.50

Contract awarded to John F. Gaynor at the price stated.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1887.

SIR: I have the honor to submit the following report of work done for the improvement of the Savannah River below Augusta, Ga., during the fiscal year ending June 30, 1887:

Work began on March 16, 1887, at Blue House Bar. Two new dams, Nos. "a" and 1, one on each side of the river above those put in last year, and one new dam, No. 3½, between the two old dams on the Georgia side were constructed. During the long continued high water of the preceding year, the river had cut away the high bank, from which Dams 2 and 4 sprung, about 120 feet, where Dam "a" is now located; about 80 feet at the end of Dam 2, and about 40 feet at the end of Dam 4. Below the latter point the cutting was slight. Dams 2 and 4 were thus left disconnected from the shore. In the gap at the inner end of Dam 2 there was a depth of 6 to 8 feet at low-water level. Dams 2 and 4 were extended to the new bank, and strong bank protections put at their new shore ends. Dam 3 had settled somewhat, and was raised to its proper level. Dam 5 had settled very much, but seemed to be safe, and the funds did not allow its being raised this year. All the dams are now in good condition, except Dam 5, which is in good shape, but too low. There are now three dams, Nos. "a," 2, and 4, on the South Carolina side, and four dams, Nos. 1, 3, 3½, and 5, on the Georgia side.

Work was finished at Blue House Bar on April 16, 1887, and the plant removed to Courses Bar, where two new dams, Nos. 11 and 12, were built. The balance of the appropriation was devoted to raising and strengthening the old dams. In two of them, gaps were closed. There are now seven dams at this crossing, Nos. 7, 8, 10, and 11, on the South Carolina side, and Nos. "b," 9, and 12, on the Georgia side. All are in good condition at the present time. Work was suspended early in May, due to the exhaustion of funds.

There was no money available for work at Sand Bar Ferry Bar.

An examination made in the latter part of June, 1887, at a stage about 1 foot above low water, shows that at each of these localities the systems of dams will have to be extended both up and down stream, and in some places intermediate dams will have to be put in before any marked benefit to navigation is obtained. There is now less than 3 feet in the best channel at each of them, the depth referring to low water.

The channel between Gardners and Courses bars has shoaled very much. It will probably be necessary to extend the system of dams from the former to the latter before a continuous deep channel can be obtained.

I am indebted to Mr. J. Tobin, of Augusta Ga., for the following information regarding the commerce passing over the Savannah River at Augusta, Ga.; there is also a considerable business carried on by steam-boats, which do not run up as far as Augusta. I have been unable to obtain definite statements as to the amount of this trade:

STATEMENT OF BUSINESS DONE ON THE SAVANNAH RIVER AT AUGUSTA, GEORGIA.

[From June 1, 1886, to June 1, 1887.]

	Tons.
Way freight, up:	
Corn and oats	300
Stores	230
Shingles	32
Cotton (513 bales)	128
Miscellaneous	95
Way freight, down:	
Guano	600
Miscellaneous	1,250
Through freight, up:	
Sugar	425
Shot	25
Sirup, molasses, and vinegar	260
Canned goods	500
Through freight, down:	
Rosin	328
Turpentine	99
Tar	18
Cotton (25,911 bales)	6,158
Miscellaneous	40
Total freight	10,488

Mr. Tobin also informs me that a new company, under the name of the Augusta Steamboat Company, has been organized, and are now building two new boats to run on the river. If these boats pay, two more boats will be built and run.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 6, 1887.

COLONEL: I have the honor to submit the following report of operations of the United States snag-boat Toccoa upon the Savannah River during the fiscal year ending June 30, 1887.

The boat, which had been laid up for more than a year, was taken to Charleston, S. C., on August 16, 1886, for repairs. These being completed, she returned to Savannah and began operations upon the Savannah River on October 12, 1886, where she was employed until February 27, 1887. During this time the whole extent of river between Augusta and Savannah was worked over, with the following results:

Number of logs, snags, and stumps removed	259
Number of overhanging trees removed	596

The river is now in better condition than it has ever before been, most of the dangerous obstructions to navigation having been removed. Hon. John Lawton, who is largely interested in steamboats on the river, writes:

"The work already done has been of great benefit, principally that done by the snag-boat Toccoa, removing sunken logs and snags. As an evidence of the improvement there has not been a single accident to a boat on the river from this cause, which has not been the case before."

To keep the river in good condition will require the services of a snag-boat yearly, not only in removing snags, but in cutting down overhanging trees which would be thrown into the river during freshets to form new snags. The amount of work required for proper annual maintenance, however, should continually decrease.

Assistant Engineer John H. Westerfield has been in immediate charge of the snag-boat during the year.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

N 8.

IMPROVEMENT OF SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

Three appropriations, aggregating $39,000, have been made by Congress since 1880 for improving Savannah River between the city of Augusta, Ga., and Trotter's Shoal, 64 miles above. The river was examined under my direction from Augusta up to the head of pole-boat navigation, near Tallulah Falls—a length of 154 miles—in November and December, 1878. My report thereon, dated February 8, 1879, is printed in Appendix I 2, Annual Report of the Chief of Engineers for 1879. I stated in the report that, until a thorough examination could be made above Trotter's Shoal, any money that might be appropriated should be expended upon that portion of the river below said shoal.

Two estimates were submitted, viz:

(1)	Cost of improving the river for pole-boat channel, 3 feet by 30 feet, from Augusta to Trotter's Shoal, 64 miles	$45,000
(2)	Cost of steamboat channel, 3 feet by 90 feet, same route	125,000

Operations have been carried on in conformity to the first-named project.

The obstructions to be removed under the adopted project are numerous, and consist chiefly of rocky ledges running across the channels, isolated bowlders of various sizes, and shoals of gravel.

No operations have been carried on since August, 1883. Previous to that time the river was more or less improved at many places within the section embraced in the project, especially in the lower reach.

From the canal lock, 7 miles above Augusta, to Barksdale, 50 miles from the city, a channel was secured through the obstructions 20 feet wide and 2½ feet deep at summer low water. The work consisted in removing solid ledge rocks, bowlders, and gravel, and in building wing, dams for contracting the water-way, the dams being constructed either entirely of broken stone or of brush-mattresses and stone combined; 4,094 cubic yards of ledge rock, 37 cubic yards of bowlders, and 62 cubic yards of gravel were removed.

For building the dams nearly 6,670 square yards of brush-mattresses and 4,183 cubic yards of broken stone were used.

As to the amount of commerce and navigation to be benefited by completing this improvement, I beg leave to refer to my report of February 8, 1879. No additional data have been received since that time.

Some of the dams put in for the removal of sand-bars have proved effective, but in many cases they have failed, as the works were neither sufficiently extensive, nor could they be properly maintained, owing to lack of funds.

I said in my report of February 8, 1879, that before a full project for the improvement of the Upper Savannah River can be intelligently prepared, more detailed information must be collected from trustworthy sources, private and corporate, interested directly or indirectly in raising and transporting the productions of that portion of the country naturally tributary to the contemplated route, and that a careful instrumental survey of a large part of the river, especially above Trotter's Shoal, would be required.

From experience gained since then it is evident that a comprehensive plan for permanently improving this portion of Savannah River would involve an excessive expenditure of funds, entirely out of proportion to the present and prospective needs of the business community of the adjacent region. I do not, therefore, recommend that further appropriations be made by Government for this improvement.

The work is located in the collection district of Savannah, Ga., which is the nearest port of entry. Amount of duties collected in 1886, $35,455.53.

Since the work of improvement was commenced the following appropriations have been made:

By act of Congress, approved June 14, 1880	$16,000
By act of Congress, approved March 3, 1881	8,000
By act of Congress, passed August 2, 1882	15,000
Total	39,000

The expenditures to June 30, 1887, aggregated $38,177.29.

Money statement.

July 1, 1886, amount available	$822.71
July 1, 1887, amount available	822.71

N 9.

IMPROVEMENT OF SAINT AUGUSTINE CREEK (THUNDERBOLT RIVER), GEORGIA.

Of the sum of $5,000 appropriated by act of Congress, approved March 3, 1879, $1,582.34 were expended during the fiscal year ending June 30, 1881, in the partial removal of the wreck of a large timber dry-dock which was sunk in the middle of the stream during the late civil war.

There appears to be no necessity for any further improvement of the river at this point, and no appropriation is asked.

This work is located in the collection district of Savannah. Savannah is the nearest port of entry. Amount of import duties collected in 1886, $35,455.53.

Money statement.

July 1, 1886, amount available	$3,417.66
July 1, 1887, amount available	3,417.66

N 10.

IMPROVEMENT OF ROMERLY MARSH, GEORGIA.

The water route through Romerly Marsh forms a part of the inland passage from the Savannah River, Georgia, to the Saint John's River, Florida. The marsh is situated to the southeast of Skiddaway Island, between Wassaw Sound on the north and Ossabaw Sound on the south.

My report, dated November 15, 1880, of an examination of Romerly Marsh, made under my direction in the latter part of the year 1880, gave descriptions of four different routes that might be selected for improvement, with estimate of cost of each. The report is printed as Appendix J 19 of the Annual Report of the Chief of Engineers for 1881, and in House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The appropriations made by Congress for the work were for "improving Romerly Marsh" by "the route designated in the survey of the engineers as route numbered 4." This route was the most easterly of those reported upon. By it the northerly creek, known as "Dead Man's Hammock Creek," which flows through the marsh and empties into Wassaw Sound near the mouth of Romerly Marsh Creek, was to be connected by a cut with Wassaw Creek, which flows into Odingsell River not far from the point where the latter empties into Ossabaw Sound. The mean rise and fall of tides is here about 7 feet.

By the selected route the passage heretofore used through Romerly Marsh would be avoided, said passage being exceedingly crooked, with sharp bends and inadequate low-water depths. Although over 2 miles longer, the new route would have the advantage of being navigated with much greater convenience.

It was proposed to give the cut a depth of 7 feet at mean low water, with a minimum bottom width of 48 feet. The cost of the work was estimated at $38,720.

Three appropriations for this improvement have been made by Congress, aggregating $37,475.

The last made by the act of August 5, 1886, amounting to $17,475, was applied to partly reimbursing certain private parties who, in 1885, had, with the approval of the Secretary of War, supplied funds for continuing and completing the project, the previous two appropriations having then been exhausted.

The work of establishing route No. 4 was commenced in May, 1883, and carried on with the usual unavoidable intermissions to its completion in April, 1886. The solid cut through the marsh was fully opened, and a channel of 50 feet width at bottom and 7 feet depth of water at mean low tide formed through the shallow water beyond the mouth of the marsh cut until sufficiently deep water in Wassaw Creek was reached. The total length of continuous cut was 4,117 feet, of which 3,547 feet were through the marsh and the balance at the head of Wassaw Creek. The work has required the removal of 211,563 cubic yards of material, at a cost of $46,712.57.

The expenditure has exceeded somewhat the original estimate, due in a large measure to the intermittent mode of providing funds, commented on in my former reports.

No work was done by the United States during the past fiscal year. A cut was made by private parties across the point of marsh near Shoal No. 1 (see report for 1886), which obviates the necessity of making the sharp turn formerly existing at that locality. Some shoaling has taken place at Shoal No. 2, and there has been some caving of the banks at the hammock and between it and the small creek which crosses the cut. The cut has, however, in general been quite well maintained during the year.

It is possible, as I have suggested on previous occasions, that some dredging may in the future be needed at places where the tides meet and the currents slacken.

The new route created by the Government is unquestionably a decided improvement upon the one formerly used, and by it sailing vessels are frequently towed through the cut, thus avoiding any risk of encountering rough weather at sea.

In view of the real value of the improvement by which one of the worst obstructed portions of the inland passage between the Savannah River and the Saint John's River has been changed into one easy and convenient for navigation, and considering the fact that the completion of the work would have been delayed and finally rendered much more expensive, if the parties referred to in this report had not, in September, 1885, furnished the means for finishing the cut, I would recommend that Congress make the necessary appropriation for the balance of funds needed to fully reimburse these parties.

I have been unable to obtain any detailed statistics of the commerce interested in this improvement.

Money statement.

July 1, 1886, amount available	$396.20
Amount appropriated by act approved August 5. 1886	17,475.00
	17,871.20
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	17,475.00
July 1, 1887, amount available	396.20
Amount (estimated) required to pay for completing of existing project	4,633.78
Amount that can be profitably expended in fiscal year ending June 30, 1889	4,633.78
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

N 11.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

The Altamaha is the most important river in Georgia, lying entirely within the boundaries of that State. It is is formed by the confluence of the Oconee and Ocmulgee. Its length is 155 miles, with a southeasterly course, and it empties into the Atlantic Ocean through Altamaha Sound, below the town of Darien.

The river was examined under my direction in the latter part of the year 1880. My report, dated November 27, 1880, with project of improvement, is printed in Appendix J 9, Annual Report of the Chief of Engineers for 1881, and in House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The chief obstructions to the navigation of the Altamaha consist in rock ledges running across the river, sand-bars and snags.

PROJECT OF IMPROVEMENT.

The project contemplates the establishment of a steamboat channel of 80 feet width and 3 feet depth at low-river stage, the cost of which was very roughly estimated at $60,000. This will probably need to be increased, as stated in previous reports. The estimate provides for the removal of about 10,500 cubic yards of rock, of an old wreck, and pile obstructions, and of several thousand snags, all in the fresh-water reaches of the river; and also for the dredging of about 8,000 cubic yards of material in the vicinity of Darien. The cost of improving localities where sand-bars occur is included in the estimate, but the latter is but roughly approximate in that respect. I said in my first report that these places should be instrumentally surveyed before a proper plan for improving them can be devised.

Three appropriations made by Congress in the years 1881, 1882, and 1884, respectively, and aggregating $35,000, were expended, or very nearly so, in improving Altamaha River, to July 15, 1885. By the act approved August 5, 1886, a fourth appropriation of $20,000 was made for continuing the improvement, "of which $10,000 are to be used on Doboy Bar, or so much thereof as may be necessary." Doboy Bar is situated in advance of the seaward entrance to Darien River, the principal navigable channel of the branches forming the delta of the Altamaha, through which it discharges its waters into the Atlantic Ocean.

OPERATIONS PRIOR TO JULY 1, 1886.

The first appropriation ($5,000) for this improvement was expended in providing a snag boat suitable for service on the river. This boat has rendered efficient service in the removal of obstructions from the numerous bends and reaches between the town of Darien and Ohoopee White Bluff, a distance of 115 miles by river.

The following work was performed under contracts referred to in previous reports:

A channel was opened through the rock ledges at Town Bluff and at Piney Bluff, 1⅝ miles and 19½ miles, respectively, from the junction of the Oconee and Ocmulgee. At Beard's Bluff, 63 miles from the junction, where the channel was obstructed by a sand-bar, an improvement was effected by building a training-wall with six spur-jetties on its channel side and by revetting caving banks. A detailed description of these operations was given in my annual report for 1886.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

The sum of $10,000 having been provided for improving Altamaha River proper, under the terms of the act approved August 5, 1886, an examination of the river was made in October of that year from the junction of the Oconee and Ocmulgee to Doctortown, 85 miles below, to determine at what points the money might be expended to the best advantage. It was decided to expend about half of it in operating with the snag-boat *Toccoa*, the balance in repairing the works at Beard's Bluff, and in removing rock from the river at Town Bluff, Piney Bluff, and Hell's Shoals, all of which places were mentioned in my last annual report as requiring attention. For such snagging work as the *Toccoa's* draught of water would not allow her to perform, a light-draught snagging scow, with suitable appliances, has been provided. Numerous snags and logs still obstruct the channels. When these are removed the river will be in a fair condition, excepting a few places where rock or sand shoals exist.

The snag-boat *Toccoa*, having been repaired and put in commission at Savannah in March last, proceeded to the Altamaha, and removed a number of overhanging trees from caving banks in the vicinity of Hughes Landing, about 70 miles below the junction. The river was too high for effective snagging work, and in the same month the boat was brought back to the Savannah River, to be used as a quarter-boat on the survey of that river until the Altamaha should be at a suitable working stage. It is expected that both the snag-boat and the snagging scow will begin work during the first weeks of the present fiscal year.

The navigation of the river has been much improved by the work already done by Government, and especially by the removal of obstructions by the snag-boat *Toccoa*.

GENERAL REMARKS.

All the products of the forests brought down the Altamaha pass through Darien, a town of 2,000 inhabitants, situated on Darien River. Practically, no business is transacted through the custom-house at Darien, except such as relates in some manner to the country drained by the Altamaha and its tributaries; but on account of the deterioration of the channel of Doboy Bar, which sea-going vessels have to use in entering or leaving Darien River, large quantities of timber are rafted down the river to Sapelo or Saint Simon's, and are not cleared through the Darien custom-house. Statistics of the port of Darien for several years past indicate that on the whole the business of that place has declined.

In 1882, when the work of improving the river was commenced, 422 vessels, of 199,667 aggregate tonnage, arrived and cleared at Darien; in 1886, 303 vessels, of 131,519 tonnage. In 1882 the value of exports amounted to $1,073,008; in 1886, to $1,037,330.

The timber shipments, foreign and coastwise, were, in 1882, 67,327,579 feet, valued at $946,027.30; in 1886, 54,425,000 feet, worth $870,940; but I am informed that in the latter year 18,290,000 feet, which had come down the Altamaha and were shipped to Sapelo and Saint Simon's, are not included in the figures just given. It should also be noted that in 1886 the foreign shipments of timber were 20,141,000 feet less than in 1885, while the coastwise shipments in 1886 exceeded those of 1885 by 19,476,000 feet. This increase in coastwise shipments is ascribed—and evidently with good reason—to the fact that coastwise shallow-draught vessels find no difficulty in crossing the bar, while the decrease in foreign shipments is due to the fact that deep-draught vessels can not cross Doboy Bar with safety.

The trade in naval stores has increased. In 1880 the shipments amounted to $12,000; in 1885 their value was $66,000; in 1886, $85,000.

The rice crop of the Altamaha in 1886 is considered to have been very good, and despite low prices was valued at $91,000. In eleven preceding years, from January 1, 1875, the shipments, all coastwise, averaged $84,000 per annum.

The shipping merchants of Darien agree in ascribing the decline of business to the condition of Doboy Bar, the navigable depth of which has gradually decreased from 22 feet in 1875 to from 18 to 18½ feet in 1886. As much timber, probably, comes down the Altamaha River as formerly; but a large part of it, on account of the bar, is rafted by the inland water route north and south, and cleared through the custom-houses at Savannah and Brunswick.

There is only one steam-boat plying on the Altamaha. Its owner estimates the value of freight carried by the boat in 1886, at $302,000, an increase of about $100,000 over the preceding year.

A large section of the State of Georgia drained by the Altamaha and its affluents has no other outlets for its products than that river, and its improvement is needed to bring those products to market. The completion of the work undertaken by the Government for improving the navigation will be advantageous to commerce and beneficial to the community generally by reducing the cost of transportation, and by encouraging the further development of the timber and naval stores industry and of the rice culture.

This work is located in the collection district of Brunswick, Ga. Darien is the nearest port of entry. Amount of duties collected in 1886, *none*.

Since the existing project for improving Altamaha River was adopted the following appropriations have been made for the work:

By act of Congress approved March 3, 1881	$5,000
By act of Congress passed August 2, 1882	15,000
By act of Congress approved July 5, 1884	15,000
*By act of Congress approved August 5, 1886	10,000
Total	45,000

The expenditures from the beginning of work to June 30, 1887, aggregated $37,961,92.

An additional sum of $30,000 is required to be appropriated to complete the project, which makes the total cost $75,000, or $15,000 more than originally estimated. This increase is necessary to provide for the cost of building wing-dams and training-walls, removing bars, and constructing bank revetments, at some points not covered by the first estimate.

The report of First Lieut. O. M. Carter, and a table of commercial statistics furnished by Mr. R. W. Grubb, deputy collector of customs, are transmitted herewith.

---

*This appropriation amounted to $20,000, but one-half of this sum was specially allotted to improving Doboy Bar.

Money statement.

July 1, 1886, amount available		$541.87
Amount appropriated by act approved August 5, 1886, $20,000, $10,000 of which to be applied to Doboy Bar		10,000.00
		10,541.87
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,678.29	
July 1, 1887, outstanding liabilities	825.50	
		3,503.79
July, 1887, amount available		7,038.08
Amount (estimated) required for completion of existing project		30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00
Submittted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

N 12.

IMPROVEMENT OF DOBOY BAR, GEORGIA.

By the river and harbor act approved August 5, 1886, an appropriation of $20,000 was made for "improving Altamaha River, Georgia, of which $10,000 are to be used on Doboy Bar, or so much thereof as may be necessary." This is the first appropriation ever made by Congress for the last-named locality.

Section 6 of the same act provided for an examination or survey "from Doboy Island to Doboy Bar." Under date of September 27, 1886, the work of making a preliminary examination of the plan referred to was assigned to my charge, and my report, accompanied by a chart of the bar, was forwarded to the Department under date of December 11, 1886.

Doboy Island is situated at the mouth of Darien River, the northerly main outlet of Altamaha River, about 12 miles below the town of Darien. The village of Doboy is located upon the western shore of the island; vessels from the port of Darien complete their cargoes at Doboy.

Doboy Bar lies southeast of the mouth of Darien River, and about 7 miles from it and 4 miles from Sapelo light-house. Vessels after crossing the bar enter Doboy Sound between Sapelo Island and Wolf Island, and through that sound reach Darien River.

According to information believed to be trustworthy, shoaling has taken place on the bar since 1875. In that year vessels drawing 22 feet could cross it; in 1885, the draught of vessels had diminished to from 18 to 18½ feet. The mean rise and fall of tides is 7.2 feet.

I did not in my report recommend that a survey of Doboy Bar be made that would have for its object the preparation of a project for its permanent improvement, for the reason that the cost would undoubtedly be too great in relation to the present importance of Darien Harbor. I suggested, however, that so much of the appropriation made for the locality as might be deemed necessary should be expended in hydraulic excavation, or propeller sluicing, so as to create a better depth of water on the bar, selecting for that purpose a new and well situated channel which the examination had shown to be in process of development. On the recommendation of the Chief of Engineers this plan was, on March 14, 1887, approved by the Secretary of War.

Since that date repeated efforts have been made to secure a suitable steamer for the work, but without success, and it being desirable that such increase in the depth of water in the bar-channel as it is possi to obtain with the limited amount of funds should be secured before next active shipping season, my recommendation of June 13, 1887, t a modification of the plan, which would admit of the employment o ordinary tug-boat, fitted up with proper appliances, be tried, was proved by the Chief of Engineers, and the work will be commen immediately.

Commercial statistics of the port of Darien, which is the shipp port for the products brought down the Altamaha, are included in annual report of operations on that river. Vessels leaving Darien bound seaward have to cross Doboy Bar.

This work is located in the collection district of Brunswick, Ga. Darien is nearest port of entry, and Sapelo the nearest light-house. Amount of revenue lected at the port of Darien in 1886, none.

Money statement.

Amount appropriated by act approved August 5, 1886, included in appropriation for Altamaha river	$10,00
July 1, 1887, amount available	10,00

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 11, 1887.

COLONEL: I have the honor to submit the following report of operations for proving Altamaha River, Georgia, during the fiscal year ending June 30, 1887:

In the river and harbor act of August 5, 1886, appropriating $20,000 for the impro ment of the Altamaha River, it is stipulated that "$10,000 are to be used on Do Bar, or so much thereof as may be necessary." The following report is divided i two sections, the first relating to the Altamaha River proper and the second to D boy Bar:

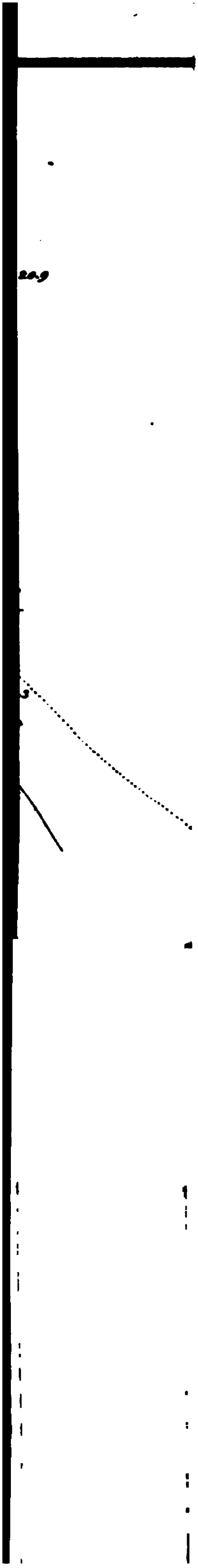
ALTAMAHA RIVER.

The United States snag-boat *Toccoa*, which was employed until February, 27, 18 upon the Savannah River, was at Savannah undergoing repairs until March 15, 18 when she left for the Altamaha River. The river being found to be at so high a st that work could not be economically done, the boat was brought back to Savann after removing 12 overhanging trees near Hughes's Landing, and used upon the s vey of the Savannah River as a quarter-boat. No other work was done upon the tamaha River during the year. As stated in my previous reports, the work of sn ging has now so far advanced on this river that but little can be done tow removing obstructions to low-water navigation except at extreme low-water sta

The *Toccoa* has become so rotten and water-logged that when the river is l enough to do the best work, her draught of water is too great to allow her to navig the river. Sufficient funds to rebuild the *Toccoa* not being available a light-drau scow with steam hoisting apparatus was purchased at a cost of $800, and operati will be resumed upon the river during the present month. As long as the *Toccoa* navigate the river both boats will be in operation, but the former will be tied whenever the river gets too low for her to work to advantage, and work will be c tinued with the scow alone.

The partially-completed improvements have been of great value. Especiall this true of the work done by the snag-boat *Toccoa*.

There is only one steamer plying on the river above Darien, and rafting interests the principal ones to be subserved by the improvement of the river. One lum dealer estimated that the work done by the *Toccoa* in one season was worth to alone over $5,000. A considerable section of country along the Altamaha has no o outlet for its products, and the improvement of this river is needed to bring t products to market.


20.9

DOBOY BAR.

With the view of determining the method and place of expenditure of the appropriation made for the improvement of Doboy Bar, an examination "from Doboy Island to Doboy Bar, Georgia," was made by me in November, 1886, as provided in the river and harbor act previously referred to, and a report was submitted, from which the following is taken:

Doboy Island is situated upon the coast of Georgia, about 50 miles, by the coast line, south of the Savannah River. It lies at the mouth of Darien River, about 12 miles, measured along the channel, below the village of Darien, and is separated by Commodore Island from Doboy Sound.

Darien River is the northerly main branch of the delta portion of the Altamaha. Through it passes the greater portion of the Altamaha River commerce. Upon the western shore of Doboy Island is situated the village of Doboy, where vessels shipping from the port of Darien receive their deep-draught loads. From Doboy to the sea the only obstruction to navigation is Doboy Bar.

The only known survey of this bar is that made by the United States Coast Survey in 1868. At that time the bar, the general direction of which has not since changed, extended ESE. from the southern end of Sapelo Island for a distance of about 3¼ miles, then in a southerly direction about parallel to the coast line for nearly 3 miles, connecting with the shoals which extended ESE. from the northern end of Wolf Island. From the mouth of Doboy Sound, between Sapelo and Wolf Islands, where low-water depths of from 4 to 6 fathoms were found, the channel extended ESE. between the sand-spits forming the shore arms of the bar for a distance of about 2¼ miles, then divided and crossed the bar in two branches, the northern one having a direction about E. by N., with minimum low-water depths of 8 feet, and the southern one extending SE. ¼ S. about 1¾ miles, and then E. by S. to sea, with minimum low-water depths of 14 feet.

The mean rise and fall of tide being 7.2 feet vessels drawing 20 feet were able to cross the bar in calm weather at mean high water; and it is claimed that on high water of spring-tides vessels of 22 feet draught have been taken from Doboy to the sea.

Since the date of that survey the bar has shoaled greatly. A preliminary examination of this bar, from the bell buoy seaward, was made by me in November, 1886, and some of the soundings taken then are shown on the accompanying chart. By referring to this it will be seen that the north or slew channel has deepened about 2¼ feet, while the south or main channel has shoaled about the same amount.

The general direction of the north channel has not changed, but the distance along that line between the inner and outer 14-foot mean low-water curves has diminished about 1,850 feet; the inner pocket having shifted to the east and moved seaward about 1,500 feet, while the outer curve has moved shoreward about 350 feet. The south or main channel has shoaled about 3 feet since 1868, its present minimum low-water depth being 11.1 feet.

From 1868 to 1879 the direction of this channel did not sensibly change.

At present its outer portion is about 1,000 feet south of its former position. The inner portion has not changed.

The "north breakers" shoal has moved to the south and west, and pushed entirely across the old channel, separating the inner and outer 14-foot mean low-water curves by a distance of about 2,000 feet. On the line of the old channel the present depths are from 8 to 9 feet as compared with 15 and 16 feet eighteen years ago. About 2,000 feet to the north of this, however, the depth of water is increasing, and a new channel is in process of formation. Beginning at a point about 1,000 feet to the north of black buoy No. 1, the 14-foot mean low-water curve has extended ESE. about 3,000 feet, the distance from the end of this pocket to the 14-foot curve on the outer slope of the bar being at present only 1,400 feet.

The material composing this bar is a mixture of fine sand and fragments of shells, and when loosened and thrown into suspension, is easily moved.

For vessels engaged in the coasting trade whose average draught is about 15 feet, the present depth of water on the bar is sufficient, but in exporting lumber and timber it is often desirable to load to 18 or 20 feet, or even to greater depths.

The foreign shipments of timber and lumber for 1886 were 19,960,000 feet, valued at a quarter of a million of dollars.

To permanently improve Doboy Bar would require the construction of contracting works of great length and cost, and I am of the opinion that the present and prospective demands of commerce are not such as to warrant the expenditure of such a sum of money.

I think, however, that a small amount can be so expended in hydraulic excavating or propeller sluicing as to give a greatly increased depth of water on the bar and a reasonably permanent channel, and I am of the opinion that, to this extent, the channel from "Doboy Island to Doboy Bar" is worthy of improvement. No survey is needed.

The population of Darien is about 2,000 and of Doboy about 400.

Doboy is in the collection district of Brunswick; Darien is the nearest port of entry.

Sapelo is the nearest light-house.

* * * * * * *

The project of improvement recommended was approved. It was found impossible to secure an American vessel suitable for propeller sluicing. At the time my report was submitted there were several suitable foreign vessels which could have been chartered for this work, but authority for the employment of such vessels was not received until May 4, 1887, when, owing to the lateness of the season, no suitable vessel could be secured, although every effort was made to do so. Propeller sluicing having to be abandoned, application was made for authority to hire a tug to be used in scraping and hydraulic excavating. This authority having been granted, work will be begun as soon as the tug can be fitted up for the purpose.

Tables of commercial statistics furnished by Mr. R. W. Grubb, deputy collector of customs, and a chart of Doboy Bar are appended hereto.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

GENERAL REMARKS REGARDING THE COMMERCE OF THE PORT OF DARIEN, FOR THE YEAR, 1886.

The timber trade.—As a comparison with the report for 1885 will show, foreign shipments have fallen off from 40,101,000 superficial feet in 1885 to 19,960,000 superficial feet in 1886. Large quantities not included in these figures, because not appearing on books in the custom-house, were shipped via Back River, Saint Simon's, Saint Simon's Mills, and Sapelo. Below are these figures:

	Superficial feet.
Via Back River, Saint Simon's	6,750,000
Via Saint Simon's Mills	5,700,000
Via Sapelo	5,840,000

With the above figures included, the foreign shipments have fallen off but little, while coastwise shipments have increased from 14,984,000, in 1885, to 34,460,000 superficial feet in 1886.

This great increase in coastwise shipments is owing, in a great degree at least, to the fact that coastwise shallow-draught vessels meet with no difficulties in crossing the bar, while the decrease in foreign shipments is due to the fact that vessels of deep draught can not safely cross it. The tendency to a steady increase manifesting itself in the coastwise trade would also affect the foreign trade if the bar offered the necessary facilities. The supply from the interior being seemingly inexhaustible, still, of course, regulated by the demand here.

Naval stores.—During the year 1886 the value of this industry increased to $85,000, considerably above what it in former years has attained. Nothing can better illustrate the truth of the statement that the falling off in foreign shipment is owing to the shallowness of water on the bar, than the fact that the naval stores manufacturers, being entirely independent of the bar, are greatly increasing their operations, while foreign-timber shipments are decreasing.

Rice.—The crop of 1886 was very good, and despite low prices its value reached $91,000.

There seems to be a general conviction in the community that with an improved bar the commerce of the port would double itself in a very short time, and this conviction is not without foundation. Regardless of our present disadvantages new saw-mills are being built all along the river, the success of old timber men who have been in the business for years apparently tempting others to try it.

In 1886 there were shipped via Sapelo and Saint Simon's, 18,290,000 feet, not included in above table.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Darien, Ga., from January 1, 1875, *to January* 1, 1887.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draught.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	Feet.
1875	77	28,063	647	....	......	......	92	47,600	1,198	169	75,663	1,845	22
1876	65	23,105	611	....	......	......	124	70,368	1,897	189	93,473	2,508	21
1877	104	54,827	1,257	3	674	22	99	50,913	1,231	206	106,414	2,510	20
1878	61	29,264	641	2	1,051	20	126	60,109	1,628	189	90,424	2,289	20
1879	58	23,275	487	3	1,199	25	115	57,710	1,407	176	82,184	1,919	19½
1880	66	21,539	489	1	668	13	134	68,072	1,608	201	90,279	2,110	19½
1881	101	40,619	849	3	1,220	29	162	84,456	1,991	266	126,295	2,869	19½
1882	117	48,208	999	1	453	9	90	51,421	1,155	208	100,082	2,163	19
1883	95	38,173	815	....	......	......	93	49,790	1,135	188	87,963	1,950	19
1884	81	34,412	714	2	606	16	92	50,178	1,133	175	85,196	1,863	19
1885	78	27,763	682	2	652	16	80	42,587	975	160	71,002	1,673	18½
1886	108	44,389	852	....	......	......	42	20,772	483	150	65,161	1,335	19

CLEARED.

Year.	Coastwise No.	Coastwise Tons.	Coastwise Crew.	American vessels No.	American vessels Tons.	American vessels Crew.	Foreign vessels No.	Foreign vessels Tons.	Foreign vessels Crew.	Total No.	Total Tons.	Total Crew.	Greatest draught. Feet.
1875	22	12,214	328	11	4,035	97	104	55,759	1,372	137	72,028	1,797	22
1876	39	9,300	270	4	1,553	32	180	87,489	2,263	223	98,342	2,565	21
1877	44	13,209	314	4	842	21	169	92,705	2,154	217	106,846	2,489	20
1878	28	7,842	181	6	3,009	62	149	83,385	1,947	183	94,236	2,190	20
1879	40	14,052	301	7	2,765	57	125	65,433	1,538	172	82,250	1,896	19½
1880	55	17,076	393	7	3,589	72	168	84,172	2,016	230	104,837	2,481	19½
1881	80	28,492	617	8	3,120	70	184	95,353	2,164	272	126,965	2,851	19½
1882	93	34,098	709	6	1,962	46	115	63,525	1,434	214	99,585	2,189	19
1883	66	25,019	519	9	3,533	72	108	56,411	1,340	183	84,963	1,931	19
1884	59	20,637	457	11	3,977	85	119	66,337	1,478	189	90,951	2,020	19
1885	46	16,649	339	8	3,354	62	98	52,742	1,198	152	72,745	1,599	18½
1886	93	38,295	719	10	3,687	80	50	24,376	564	153	66,358	1,363	19

Timber shipments from port of Darien, Ga., from January 1, 1875, *to January* 1, 1887.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
1875	41,447,024	$557,524	10,992,600	$181,377.00	52,439,624	$738,901.00
1876	60,762,000	735,099	8,370,000	138,105.00	69,132,000	873,204.00
1877	64,378,000	776,856	11,888,100	196,153.65	76,266,100	973,009.65
1878	59,697,124	716,365	7,057,800	116,453.70	66,754,924	832,818.70
1879	47,217,818	566,613	12,646,800	208,672.20	59,864,618	775,285.20
1880	74,612,520	895,350	15,368,500	253,578.60	89,981,020	1,148,928.60
1881	65,420,876	785,050	25,642,800	423,106.20	91,063,676	1,208,156.20
1882	36,639,379	439,672	30,688,200	506,355.30	67,327,579	946,027.30
1883	42,385,000	508,620	22,517,100	371,532.15	64,902,100	880,152.15
1884	50,656,000	607,872	18,573,300	306,459.45	69,229,300	914,331.45
1885	40,101,000	501,262	14,984,100	247,937.65	55,085,100	749,199.65
1886	19,960,000	219,500	34,465,000	661,440.00	54,425,000	870,940.00
Total	603,276,741	7,309,783	213,194,300	3,601,170.90	816,471,041	10,910,953.90

COMMERCE.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1,621,904	$5,600	$11,806.72
1881	1,137,496	3,356	18,980.02
1882	1,073,008	1,025	11,254.19
1883	969,834	2,334	11,067.37
1884	1,038,185	11	9,688.20
1885	860,500	....	2,359.01
1886	1,037,330	....	....

R. W. GRUBB,
Deputy Collector, Port of Darien.

N 13.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

The city of Brunswick, Ga., is situated on a bluff on East River, a branch of Turtle River. A little over a mile below the city the East River flows into Brunswick River, which enters the Atlantic Ocean through Saint Simon's Sound, 9 miles east of Brunswick.

The improvement required at Brunswick Harbor consists in the removal of an extensive shoal obstructing the ship-channel in East River about a mile below the city, where heretofore a low-water depth of only 9 feet existed. The available low-water depth on the sea-bar is 16 to 17 feet; the mean rise and fall of tides, 6.8 feet.

The appropriations made by Congress for this work since 1879 aggregate $92,500. Previously an appropriation of $10,000 had been made by the act approved July 4, 1836, and expended in partially removing the shoal referred to.

By the work of improvement undertaken by Government it is intended to establish and maintain a ship-channel of 15 feet depth at mean low water, equivalent to about 22 feet at mean high water, through the shoal in East River.

The original project of improvement, described in my annual report of 1880, printed as Appendix J 7, Annual Report of the Chief of Engineers for the same year, provided for the construction of a jetty or training-wall in East River for the purpose of contracting the waterway and concentrating the currents over the shoal, and for dredging along the line where the channel was desired to be located. The cost of this project was estimated at $73,187. It was expected at that time, and was so stated in my reports, that additional works would eventually be needed to increase the ebb flow in East River.

For some years past it had become evident that the existing project must be enlarged in order to secure the permanent lowering of the refractory shoal to a minimum low-water depth of 15 feet. The additional works thought to be needed for that purpose were briefly described in my last annual report. The enlarged project provides for the following works, including those forming the original plan:

ENLARGED PROJECT.

(1) A training-wall projecting from the northeasterly point of Buzzard's Island, located approximately parallel to and 1,000 feet or less distant from the opposite shore of East River.

(2) A low dam across Turtle River, extending obliquely up-stream from the upper end of Buzzard's Island to the opposite shore of Blythe Island. The dam is designed to deflect a larger volume of water at ebb tide into East River.

(3) Short spur-jetties in the lower part of East River, either on the right or left bank, or on both banks.

They are intended to contract the water-way at places where its width is greater than consistent with a permanent maintenance of proper depths.

(4) Dredging in the vicinity of Turtle River Dam to facilitate the entrance of a larger amount of water into East River, and dredging on the shoal in the lower part of that river. The cost of the enlarged project is estimated at $190,000, inclusive of amounts already appropriated.

OPERATIONS PRIOR TO JULY 1, 1886.

The training-wall was laid for a length of 4,199 feet.

Its head reached the 18-foot low-water curve at the lower junction of the East River and Turtle River and entrance into Brunswick River. Its upper end is joined to the east shore of Buzzard's Island by a return face of 310 feet length. The top of the return face was brought up to the height of 2 or 3 feet above the mean low-water line; the training-wall rose generally nearly up to that line except near the outer end, which passes through deep water. These works are constructed partly of palmetto cribs filled with brush and dredged material, topped off with riprap stone and resting upon timber platforms, and partly of log mattresses overlaid with brush and loaded with stone. Further particulars about the training-wall were given in my annual report of last year, and in preceding reports.

Dredging was carried on upon four adjoining lines, parallel to the training-wall and about 240 yards east of it. The cuts, which varied from 20 to 25 feet in width, were intended to run from the upper 15-foot curve in East River to the lower 15-foot curve at the entrance into Brunswick River, a distance of about 4,900 feet; but only one cut was made of that length, and its upper 1,000 feet had only a depth of 12 feet at low water. Two other cuts had nearly the required length, with the full depth of 15 feet; while a fourth cut, of 12 feet, had been only begun. In the ranges where these operations had been carried on, the original low-water depths varied from 8 to 11 feet.

The material removed consisted of sand, loam, and clay, mixed in varying proportions and amounted to 80,502 cubic yards.

In June, 1886, the training-wall was in good condition, but more or less shoaling had taken place in the dredged channel. No dredging had been done here since April, 1883, and since the training-wall had not been built up to a sufficient height, and other necessary work contemplated by the enlarged project had not been done, the ebb currents over the shoal had not the strength to keep the cuts open.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

When the appropriation of $22,500, made by the act approved August 5, 1886, became available, it was deemed best to expend about $10,000 for dredging and the balance for jetty work. The appropriation was not large enough to begin any other work required under the enlarged project described in this report. The specifications for jetty work were essentially like those which accompanied the last contract, made in September, 1884, and described in my annual report of 1884, except that the logs and binders for the new mattresses were to be somewhat thicker.

A contract for the work was made with Mr. Edward H. Gaynor.

The contract for dredging was awarded to the Savannah Dredging Company of Savannah, Ga.

Dredging was commenced on December 24, 1886, and terminated on February 28, 1887.

A uniform depth of 14 feet was obtained through the shoal, from the corresponding upper curve in East River to the lower one at the mouth; the aggregate width of cuts was 40 feet at the upper end and 80 feet at the lower; 40,000 cubic yards of material were removed. Under the Gaynor contract the return face was brought up to the level of mean high water, and the training-wall to 4 feet above mean low water at the angle, gradually sloping down to the level of mean low water at a point 780 feet down stream.

The mattresses varied from 15 to 30 feet in width. For this work 9,674¾ square yards of mattresses and 1,448 cubic yards of riprap stone were used. Operations were suspended on May 28, 1887, the appropriation having been exhausted.

With any funds that may be made available it is proposed to carry on the work in conformity to the enlarged project at such points and in such order as a local examination, to be made at the proper time, may show to be most advantageous.

CONDITION OF THE IMPROVEMENT.

The jetty or training-wall is in good condition; its older part is cemented together by oyster shells and barnacles.

In the improved channel, from Brunswick River to the wharves of the city, the available minimum depth is now not less than 14 feet. It is expected that this depth will, to a large extent, be maintained, since the return face and the main-work have been raised to greater height, thereby inducing a greater flow of water in the channel. Previously the tidal currents crossed the work obliquely, the greatest velocities of these currents being found just below the angle.

GENERAL REMARKS.

It may well be said that Brunswick is a growing city. According to the census of 1880 the place had a population of 2,891; in 1887 it is estimated at about 8,000. In the first-named year the taxable property amounted to $1,404,000, in 1886, to $2,301,260, and it is claimed that in the current year it has already increased over half a million dollars.

Comparing the amount of commerce and navigation of Brunswick in 1880, when the work of improvement was commenced, with that in 1886, an increase in the latter year is shown. At the same time it should be stated that the last-named year was less favored than the three preceding ones, in each of which the value of trade aggregated over $3,000,000.

The decrease in 1886 is ascribed to the bad condition of the railroads terminating at Brunswick—the Macon and Brunswick Railroad and the Brunswick and Albany Railroad. I am informed that these roads are now being put in good order, and that expectations are entertained that the business of 1887 will exceed that of any previous year.

Comparative commercial statistics of the port of Brunswick, Ga., in the years 1880 *and* 1886, *respectively.*

	1880.	1886.
Value of total exports and imports	$1,710,668	$2,832,053
Shipment of lumber, feet	72,064,000	83,919,434
Shipment of rosin, barrels	86,540	105,992
Shipment of spirits of turpentine, casks	9,021	36,249

Until lately but little cotton has been shipped from this port, but it seems that this business is now beginning to develop. In 1886 24,269 bales, valued at $1,163,792, were shipped, chiefly coastwise.

Vessels and tonnage entered and cleared through the custom-house.

Year.	Vessel.		Average per vessel.
	No.	*Tons.*	*Tons.*
1880	678	207,771	307
1886	652	270,132	414

The total arrivals and clearances in 1886, including vessels not entered or cleared through the custom-house, are said to have been 1,867 vessels of an aggregate tonnage of 630,772.

To show the value of Brunswick as a maritime port, with its present unimproved channel over the outer bar, I have been furnished by the collector of the port with a partial list of deep-draught sailing vessels that crossed the sea-bar in 1886.

The list gives the names of five vessels drawing 21 feet 6 inches to 21 feet 8 inches that crossed the bar without the aid of steam-tugs, and the names of eighteen vessels drawing 20 feet 6 inches to 21 feet 8 inches aided by steam.

I learn that in the early part of the current year a board of trade was organized in Brunswick, and it is anticipated that in the future full statistics can be more readily obtained.

From all appearance the city of Brunswick will continue to increase in population and commercial importance, and I consider it desirable that the necessary funds be provided by Government to complete the improvement of the harbor.

This work is located in the collection district of Brunswick, Ga., at the port of entry. Amount of import and other duties collected in 1886, $5,834.43.

Since the original plan of improvement was adopted, the following appropriations have been made:

By act of Congress approved March 3, 1879	$20,000
By act of Congress approved June 14, 1880	10,000
By act of Congress approved March 3, 1881	5,000
By act of Congress passed August 2, 1882	25,000
By act of Congress approved July 5, 1884	10,000
By act of Congress approved August 5, 1886	22,500
Total	92,500

Of this amount there has been expended to June 30, 1887, the sum of $92,411.56.

A chart of Brunswick Harbor, showing condition of improvement June 30, 1887, and the report of First Lieut. O. M. Carter, Corps of E gineers, with commercial statistics furnished by the collector of t port, are herewith transmitted.

Money statement.

July 1, 1886, amount available		$128.1
Amount appropriated by act approved August 5, 1886		22,500.
		22,628.1
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$22,504.75	
July 1, 1887, outstanding liabilities	35.00	
		22,539.7
July 1, 1887, amount available		88.4
Amount (estimated) required for completion of existing project		97,500.
Amount that can be profitably expended in fiscal year ending June 30, 1889		75,000.

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging in Brunswick Harbor, Georgia, opened September 3 1886.

No.	Names of bidders.	Price per cubic yar
		Cents.
1	P. Sanford Ross	26
2	Morris and Cumings Dredging Company	29
3	American Dredging Company	28
4	Savannah Dredging Company	26

Contract awarded to the Savannah Dredging Company, at price stated.

Abstract of proposals for continuing construction of jetty in Brunswick Harbor, Georgia, opened September 30, 1886.

No.	Names of bidders.	Mattresses, per square yard.	Stone, per cubic yard.	Aggregate cost of the work.
		Cents.		
1	Anson M. Bangs	70	$3.10	$9,075
2	Edward H. Gaynor	55	3.00	8,400

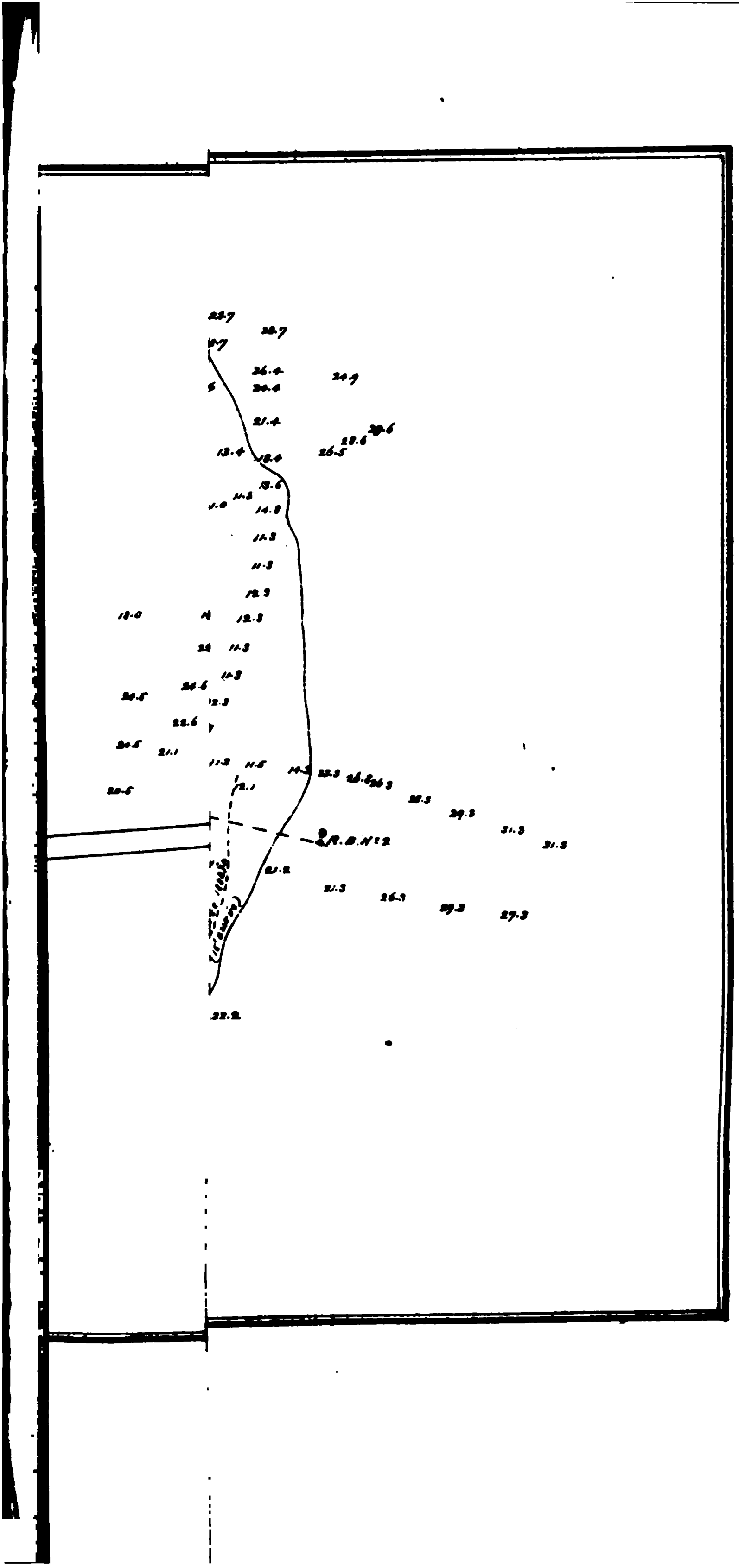
Contract awarded to Edward H. Gaynor, at the prices stated.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 9, 1887.

COLONEL: I have the honor to submit the following report of operations for improving the harbor at Brunswick, Ga., for the fiscal year ending June 30, 1887.

The work has consisted in raising the training-wall opposite the city with log and bush mattresses loaded with riprap stone, and in dredging. The stone and mattress


22.7
28.7
26.4
24.9
20.4
21.4
29.6
28.6
13.4
18.4
26.5
13.6
11.8
14.8
11.3
11.3
12.3
18.0
12.3
11.3
11.3
24.6
20.5
12.3
22.6
20.5
21.1
11.3
11.5
14.3
22.3
26.8
26.3
28.3
29.3
31.3
20.5
12.1
R.B.No 2
31.3
21.2
21.3
26.3
29.2
27.3
22.2

work was done under contract with Mr. Edward H. Gaynor, of Boston, Mass., and the dredging under contract with the Savannah Dredging Company, of Savannah, Ga.

The dredging was done along the sailing range in front of the city. Forty thousand cubic yards were removed, leaving a channel from 40 to 80 feet in width, with a least mean low-water depth of 14 feet.

At the close of the last fiscal year the crest of the trailing wall opposite the city was in places from 4 to 6 feet below mean low water, and the tidal currents, both on the flood and on the ebb, passed diagonally across it, the greatest velocities being found just below the angle point. A strong current also set across the return face of the work.

During the past year this was brought up to mean high water, and the main work to 4 feet above mean low water at the angle, gradually sloping down to the level of mean low water at a point 780 feet beyond.

The old palmetto crib-work was too narrow to build upon, and a foundation course of mattresses, 30 feet in width, was laid behind these cribs and close against them. Upon this, courses of 20-foot mattresses were laid until the work was raised to the level of the old cribs. The next course then overlapped the old crib-work, and upon this new crest 15-foot mattresses were laid.

The following tables show the work done during the year:

DREDGING.

	Cubic yards.
December, 1886	2,840.5
January, 1887	20,756.2
February, 1887	16,403.3
Total	40,000

JETTY WORK.

Date.	Mats.	Stone.
1887.	*Square yards.*	*Cubic yards.*
February	2,084.82	257.86
March	3,466.43	469.83
April	2,594.82	343.35
May	1,528.68	377.01
Total	9,674.75	1,448.05

Stone and logs soon after being laid are covered with a growth of shells, and closely cemented together. The work is in good condition, but should be raised to a higher level as soon as funds are available. Two spurs should be constructed above the return face of the training-wall to reduce the width of the river at that point.

During the year some wharves have been constructed, which extend beyond the authorized bulkhead line. These projecting wharves, and the method of mooring vessels, referred to in my last report, continue to cause shoaling along part of the city front.

The tables of statistics, which are hereto appended, show a steady growth of the commerce of the port since the work of improvement was begun in 1880. The naval stores trade has almost quadrupled within the past six years. The shipments of lumber for the year 1886 amounted to nearly 84,000,000 feet. The cotton trade is rapidly growing; 43,000 bales were shipped during the six months ending December 31, 1886, this being nearly twice as much as was shipped during the entire year of 1885. There are two lines of railway, the East Tennessee, Virginia and Georgia, and the Brunswick and Western, which have this port for their outlet. The population of Brunswick in 1880 was less than 3,000. It is now 8,000.

A chart showing the present depths of water in the channel is transmitted herewith.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Brunswick, Ga., from January 1, 1878, to December 31, 1886.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1878	116	32,584	850	36	10,218	270	41	19,008	493	193	61,810	1,613
1879	148	44,397	1,090	33	8,235	232	40	17,589	468	221	70,221	1,790
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088
1882	335	123,149	2,659	7	2,095	57	63	26,958	694	405	152,202	3,416
1883	299	110,302	2,368	11	4,814	107	87	40,765	979	397	155,881	3,454
1884	239	88,063	1,893	10	4,434	88	126	62,818	1,435	375	155,315	3,416
1885	242	93,280	1,928	10	3,216	97	94	43,284	1,037	346	139,780	3,052
1886	229	88,244	1,751	7	3,262	48	98	47,798	1,164	334	139,304	2,835

CLEARED.

Years.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1878	124	32,767	874	28	9,231	236	49	21,218	550	201	63,216	1,660
1879	157	42,345	1,116	21	7,172	172	47	21,730	555	225	71,247	1,843
1880	270	78,913	2,010	14	5,010	115	48	19,970	550	332	103,900	2,675
1881	252	82,155	1,732	17	7,218	156	87	42,659	1,014	356	132,032	2,902
1882	278	96,170	2,086	19	7,761	170	101	48,699	1,139	398	152,630	3,395
1883	257	91,036	1,962	28	11,268	240	124	55,717	1,369	411	158,021	3,571
1884	176	62,927	1,322	38	16,209	335	148	70,612	1,633	362	149,748	3,290
1885	196	71,345	1,481	21	8,696	190	135	62,437	1,456	352	142,478	3,127
1886	184	67,020	1,413	17	7,528	150	117	56,280	1.305	318	130,828	2 877

COMMERCE.

Years.	Value of exports.	Value of imports.	Total collections.
1878	$1,372,842	$400	$4,500.97
1879	1,394,401	3,197	5,644.33
1880	1,702,570	8,098	17,723.27
1881	2,230,000	4,377	29,305.30
1882	2,700,000	2,739	20,058.90
1883	3,437,000	3,003	24,911.61
1884	3,500,000	958	19,730.82
1885	3,063,960	4,008	3,939.27
1886	2,828,656	3,397	5,834.43

Comparative statement of receipts and shipments of naval stores.

Years.	Receipts (barrels).						Shipments (barrels).							
	Stock on hand.		Receipts for year.		Total.		Coastwise and interior towns.		Foreign.		Stock on hand.		Total.	
	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.
1880	3,000	600	36,495	8,661	39,495	9,261	29,339	8,371	7,201	650	2,935	240	39,475	9,261
1881	2,935	240	67,562	13,490	70,297	13,730	37,029	8,621	18,077	3,009	15,191	2,100	70,297	13,730
1882	15,191	2,100	104,357	23,459	119,548	25,559	46,785	11,533	52,972	11,826	19,791	2,200	119,548	25,559
1883	19,791	2,200	80,078	16,105	99,769	18,305	9,846	5,183	74,687	12,229	15,236	893	99,769	18,305
1884	15,236	893	105,622	23,449	120,858	24,342	22,850	2,565	98,983	20,167	8,016	1,610	120,858	24,342
1885	8,016	1,610	92 958	20,900	100,974	22,510	20,197	3,556	68,814	16,169	11,963	2,785	100,974	22,510
1886	11,963	2,785	139,366	34,625	151,329	37,410	30,898	15,620	75,094	20,629	45,337	1,161	151,129	37,410

JACOB E. DART,
Collector.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

N 14.

IMPROVEMENT OF THE ENTRANCE TO CUMBERLAND SOUND, BETWEEN GEORGIA AND FLORIDA.

The entrance to Cumberland Sound is situated between Cumberland Island, Ga., on the north, and Amelia Island, Fla., on the south. A port of entry is located at Saint Mary's, Ga., on Saint Mary's River, 6½ miles from the inner end of the entrance, and another port of entry at Fernandina, Fla., on Amelia River, 3 miles from the same point.

Five appropriations, aggregating $367,500, have thus far been made by Congress for improving this entrance.

PROJECT OF IMPROVEMENT.

The plan for the improvement of the entrance to Cumberland Sound, Georgia and Florida, submitted with my report of June 30, 1879, printed as Appendix I 8, Annual Report of the Chief of Engineers for 1879, comprises the construction of two low jetties composed of riprap stone, resting upon a foundation mattress of logs, or logs and brush, starting, respectively, from the shores on opposite sides of the entrance and extending seawards across the bar upon lines so directed that the outer ends will be parallel to each other, and from 3,000 feet to 3,500 feet apart, or such distance as may hereafter be deemed necessary. The available low-water depth has heretofore varied from 11 feet to 13 feet, with a mean rise and fall of tides of about 6 feet. Two low jetties reaching entirely across the bar would be expected to maintain a low-water channel not less than 20 to 21 feet deep. Greater depth may be secured by carrying the jetties to higher levels.

The cost of the work was estimated at $2,071,023.

On account of the small appropriations hitherto made for this improvement, entirely disproportionate to its magnitude, and the frequent and prolonged suspension of operations resulting therefrom, this original estimate of cost will probably be considerably exceeded.

OPERATIONS PREVIOUS TO JULY 1, 1886.

North jetty.—This work was commenced in June, 1881. From its shore end (or Cumberland Island) the foundation course extends 2,200 feet on a range south 63½ degrees east crossing Cumberland Channel. It then follows another range bearing south 80 degrees east for a length of 5,172 feet. The present seaward end of this course is located in shallow water, not far from the North Breakers, north of Pelican Shoal. The mattresses are from 25 to 52 feet wide, and from 19 to 22 inches thick. Where the jetty crosses the deeper portion of Cumberland Channel a second course of mattresses, from 20 to 25 feet wide, was placed, and the foundation courses for two spur-jetties were laid on the south side of the work.

South jetty.—The south jetty was commenced in June, 1882. Its starting point is located on the eastern shore of Amelia Island, about 5,700 feet from Fort Clinch. From that point the bottom course was laid due east 1,619 feet; thence it followed a range north 68 degrees 32 minutes east to a point 6,048 feet from the angle point. The mattresses vary from 40 to 100 feet in width, and average 18 inches in thickness. For about half a mile from the shore end the jetty runs through comparatively shallow water; the rest of its length passes through water of from 17 to 20 feet depth at mean low tide.

The following quantities of materials were employed in the work previous to July 1, 1886:

	Mattresses.	Riprap stone.
	Sq. yds.	*Cu. yds.*
North jetty	46,480	15,612
South jetty	74,170	23,280
Total	120,650	38,892

The lengths of the foundation courses, measured along their axes, were, on June 30, 1886:

	Feet.
Length of foundation course of north jetty	7,372
Length of foundation course of south jetty	7,667

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

For continuing this improvement the sum of $112,500 was appropriated by the act of Congress approved August 5, 1886.

The work done during the fiscal year was confined to the south jetty, and consisted in extending the foundation course seaward 2,396 feet, and in commencing a second course, under a contract made with Mr. Anson M. Bangs.

In my last annual report I briefly described the changes in the position and direction of the sailing line across the bar since 1880, and I observed that in April, 1886, that line was only about 600 feet north of the then seaward end of the bottom course of the south jetty, or about a thousand feet further south than the axis of the new channel is proposed to be located. To prevent further shifting southward of the sailing line, the first operations during the past fiscal year consisted in extending the foundation course of the south jetty, using mattresses of 100 feet width covered with 12 inches of riprap stone. This extension was laid upon ranges or chords of 400 feet length, corresponding approximately to the arc of a circle of about three miles radius, and tangential to the second range previously followed. By this method it is intended to reach a suitable point for the final seaward end of the jetty on the outer slope of the bar, and to cause a favorable change in the direction of the sailing line.

When the work had thus been extended nearly 2,400 feet, the last-named object had been accomplished so far that the ebb currents were found to run parallel to the axis of the jetty instead of showing a tendency to approach it, and it was deemed advisable to suspend for the present the further extension of the foundation and give needed attention to another part of the jetty.

I remarked in my last report that a strong ebb current set to the southeast across the jetty, which had settled somewhat at the angle formed by the two ranges on which the work was laid. It was decided to expend the balance of the appropriation in raising the jetty in this vicinity by laying a second course of mattresses, 100 feet wide, covered with about 12 inches of riprap stone, with a view to diminishing the overpour of water at ebb tide. This second course commences at a point 2,959.33 feet from the shore end, or about one-fourth of a mile east of the angle referred to. At the close of the fiscal year it had been extended continuously 462.8 feet.

The material used in the work during the past fiscal year amounted to 33,303 square yards of log-and-brush mattresses, and 10,336 cubic yards of riprap stone.

On June 30, 1887, the lengths of the two jetties, measured along their axes, were as follows:

	Feet.
North jetty:	
Length of foundation course	7,372
Length of second course	1,493
South jetty:	
Length of foundation course	10,063
Length of second course	463

CONDITION OF THE IMPROVEMENT.

The north jetty is in fair condition; no noteworthy changes have occurred during the year.

The mattresses of the south jetty are completely sanded over for the entire length. On the inner side the slope of the ground toward the channel is very gentle; on the outer or seaward side the slope is steeper, and at some points there are indications of scour, due to the overpour during ebb-tide. Strong ebb currents continue to set across the jetty at the deep pocket east of the angle of range 1–2. Near the seaward end these currents now run parallel to the work, as stated above, and the sailing line has shifted several hundred feet northward of the position it occupied a year ago.

The least available low-water depth on the present sailing range is 14.1 feet. Vessels of 20-feet draught have crossed the bar during the past year, while formerly 19 feet was the maximum.

Generally, it may be said that no material changes have taken place since my last report, and it may be added that none more favorable could be expected, considering the comparatively small amount of funds that were available for operations. Such improvements on the bar as were produced by work previously done have been maintained. No decided progress in the formation of the new bar channel can be made until both jetties are raised to greater heights and extended across the bar, confining the future channel between them. At present the seaward end of the foundation course of the south jetty is over 2 miles in advance of that of the north jetty, but it is still at a distance of about half a mile from the point on the outer slope of the bar which it is intended to reach.

It is now seven years since the first appropriation was made for this improvement. During that period operations have been carried on for thirty-three months, and have been suspended for want of funds fifty-one months. No serious damage has yet occurred to either jetty, for the reason, probably, that work has been confined to the foundations. But as their heights approach the low-water level where they will be exposed to the destructive action of waves and currents, serious injury, and corresponding expense for repairs, may reasonably be anticipated, if more regular and adequate appropriations are not made by which the work can be carried on continuously to completion. Only about 18 per cent., *equal to 2½ per cent. per annum*, of the original estimated cost of the work has thus far been provided. At this rate, allowing for deterioration while operations are suspended, an approximate estimate would indicate fifty years as the time required for completing the improvement. In view of these facts, I can only urge again the propriety of more liberal appropriations for this work, if it is desired that the commercial advantages which it is designed to secure shall be realized within a reasonable period of time.

COMMERCE AND NAVIGATION.

The following tables, giving commercial statistics for the year 1881, when work on the jetties was commenced, and 1886, are taken from the official statements courteously furnished by the collectors of customs at the ports of Fernandina, Fla., and Saint Mary's, Ga.:

Arrivals and clearances of vessels at Fernandina, Fla.

	Arrived.				Cleared.			
	1881.		1886.		1881.		1866.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Coastwise	227	171,548	205	147,418	204	138,598	214	153,092
Foreign ports:								
American vessels	17	11,865	7	2,112	41	22,007	27	9,073
Foreign vessels	24	11,592	15	5,187	31	15,335	26	9,817
Total	268	195,005	227	154,717	276	175,940	267	171,981

Arrivals and clearances of vessels at Saint Mary's, Ga.

	Arrived.				Cleared.			
	1881.		1886.		1881.		1888.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Coastwise	22	7,451	20	7,882	22	7,541	20	7,882
Foreign:								
American vessels	6	2,491	1	321	7	3,362	5	2,312
Foreign vessels	25	11,292	6	2,085	29	12,463	5	1,646
Total	53	21,324	27	10,288	58	23,366	30	11,840

The total value of the commerce of Fernandina is stated to have been in 1881, $3,104,831; in 1885, $3,855,991. I have received no corresponding statement for the year 1886, but it appears that among the staple articles of commerce, 30,469,000 feet of lumber and 8,609 bales of cotton were shipped during the year.

The statistics of the port of Saint Mary's are very meager. It is stated that recently the coastwise shipment of staples has amounted to 150,000 bushels of rice, 25,000 barrels of rosin, and 5,000 barrels of spirits of turpentine.

I have been unable to obtain reliable information relating to the rates of freight and insurance, or the rates of competing routes of transportation, for these ports. If, however, any favorable changes have occurred since 1881, they can not properly be attributed to the influence of the slight improvement in the channel thus far accomplished.

Fernandina, the more important of the two ports of entry at Cumberland Sound, is by nature the most favored harbor on the Atlantic coast of Florida. Inside the bar the anchorage is capacious, deep, and well sheltered from storms. The wharves of Fernandina are about 6 miles from the sea-bar; those of Saint Mary's, about 10 miles distant, are reached through the Saint Mary's River. About 20 miles above the town of Saint Mary's the water is fresh and deep, well adapted as a place of rendezvous for iron-clads and other iron-hulled vessels, where they will be free from barnacles and the corroding action of salt-water.

The establishment of an improved channel across the bar, as contemplated by the existing project, would undoubtedly soon raise Fernandina to a high rank as a shipping port and as a harbor of refuge, and would permit the realization of a long contemplated project for a direct line of steamers between Fernandina and Liverpool. At present the Florida Railway and Navigation Company's system extends over a large portion of northern Florida, with its eastern terminus at Fernandina; and semi-weekly steamers ply between that place and northern ports. A few years ago a railroad enterprise was suggested with a view to connecting the Atlantic and Pacific oceans, with Fernandina as its eastern terminus, and a Mexican harbor on the Gulf of California at the western end. This line, when completed, would probably be the shortest transcontinental route between the Atlantic and Pacific coasts. It would furnish access to and aid the development of the extensive mineral deposits and mines on its western division, while the eastern, with its lateral connections, would afford transportation to the Atlantic coast for the products of the coal and iron regions of Georgia and Alabama, of the pine forests of these and other Southern and Southwestern States, and of the cotton districts generally. But the value of such a route to the commerce and navigation of the country, and of the ports at the entrance to Cumberland Sound in particular, will not be fully developed until the improvement of that entrance shall have been completed.

This work is located in two collection districts, the North Jetty being in the district of Saint Mary's, Ga., and the South Jetty in that of Fernandina, Fla.

Fernandina is the nearest port of entry. Import duties collected during the year 1886, $1,808.

The following appropriations have been made for this improvement:

By act of Congress approved June 14, 1880	$30,000
By act of Congress approved March 3, 1881	100,000
By act of Congress passed August 2, 1882	50,000
By act of Congress approved July 5, 1884	75,000
By act of Congress approved August 5, 1886	112,500
Total	367,500

The expenditures to June 30, 1887, aggregated $306,782.64.

The following papers and drawing accompany this report:

(1) Chart showing improvement of Cumberland Sound, Georgia and Florida, to June 30, 1887.
(2) Report of First Lieut. O. M. Carter, Corps of Engineers.
(3) Commercial statistics furnished by the collector of the port of Fernandina, Fla.
(4) Commercial statistics furnished by the collector of the port of Saint Mary's, Ga.

Money statement.

July 1, 1886, amount available		$764.64
Amount appropriated by act approved August 5, 1886		112,500.00
		113,264.64
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$29,650.16	
July 1, 1887, outstanding liabilities	22,897.12	
		52,547.28
July 1, 1887, amount available		60,717.36

Amount (estimated) required for completion of existing project	1,703,523.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for construction of jetties at Cumberland Sound, Georgia and Fl opened September 30, 1886.

No.	Names of bidders.	Mattresses, per square yard.	Stone per cubic yard.	Agg r cost o wo
1	P. Sanford Ross	$0.58	$2.90	
2	Rittenhouse Moore	.48	3.00	
3	Anson M. Bangs	.47	2.89	
4	Lara & Ross	.54	3.04	
5	E. H. Gaynor	.49	3.00	

Contract awarded to Anson M. Bangs at the price stated.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 11, 188

COLONEL: I have the honor to submit the following report of operations fo proving Cumberland Sound, Georgia and Florida, during the fiscal year e June 30, 1887.

Operations were begun on January 26, 1887, under contract with Mr. An Bangs, of Fayetteville, N. Y., and have been confined to the South Jetty, whic been extended and raised with log and brush mattresses loaded with riprap st

The foundation course was extended from a point 7,667 feet from the shore e point 10,062.48 feet distant; an advance of 2,395.48 feet.

The mattresses used in this extension were 100 feet in width and were loaded 12 inches of riprap stone.

The foundation-course of the jetty having been extended far enough seaw prevent a further shifting of the bar channel to the southward, operations there suspended and work upon the second course was begun in the deep-water p near the angle at a point 2,959.33 feet from the shore end, and extended to a 3,422.13 feet distant; an advance of 462.8 feet during the year.

The original foundation-course near the angle being too narrow, mattresses feet in width were used upon the second course. They were at first loaded wi inches of riprap stone, but this proving insufficient it was increased to 12 i An examination of the South Jetty shows a well-defined mound rising to from 1 feet above the general level of the bottom. The mattresses have completely s over throughout the entire length of the jetty. On the channel side of the jett bottom slope is gradual—about 1 foot in 50. On the sea side it is more abrup indications are found of a small trench along the jetty which has been scoure by the overpour of the ebb tide.

The North Jetty has not changed during the year. The high and low water near the South Jetty have moved seaward since the survey of 1885 an average dis of about 200 feet each. A strong ebb current still sets to the southeast acros South Jetty, near the angle. At the seaward end of the jetty the ebb curren now parallel to the axis of the work. Measured along the outer crest of the b sailing range has shifted about 850 feet to the northward since my last report. least low water depth on the present sailing range is 14.1 feet, although the lumps near the channel over which the depth is from 1 to 2 feet less. V of 20 feet draught have crossed the bar during the past year, the greatest dr previous to this time being 19 feet.

From the tables of statistics compiled by the collector of customs at Fernandin appended hereto it will be seen that the total amount of the commerce of Ferna for the year 1886 was over four and a half million dollars since the work of imp ment at that locality was begun in 1881, and an increase of more than three-qu of a million dollars over that of the previous year.

The tonnage and number of vessels entered and cleared have decreased durin past six years. As the appropriations have been irregular and entirely inade the works of improvement have only been begun, and no changes in rates of f and insurance, nor in the rates of competing routes of transportation, can be a uted to their influence. Fernandina is the eastern terminus of the F. R. & N. pany's system, and two lines of steamers ply between that and Northern ports.

A chart showing the condition of the improvement is transmitted herewith.

t /

ment of

rbor, Ga.

, 1887.

ction of

Engineers, Bvt. Maj. Gen. U.S.

Engineers, U.S.A. in local

Feet.

1000

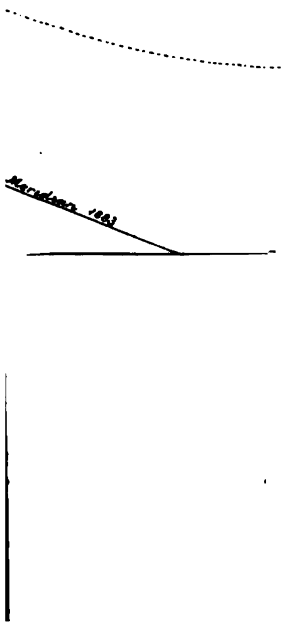
al report of July 30. 1887.

ding June 30. 1887.

Q. A. Gillmore

Colonel of Engineers

Bvt. Maj. Genl U.S.A.



The following table shows the work done on the south jetty during the year:

JETTY WORK.

[Locality, South Jetty.]

Date.	Mats.	Stone.	Advance in feet.	
			First course.	Second course.
First course:	*Sq. yds.*	*Cu. yds.*		
January, 1887	336.82	60.23	22.62	....
February, 1887	5,411.14	1,760.69	463.42	....
March, 1887	6,028.70	1,724.11	522.80	....
April, 1887	6,719.86	1,803.15	576.84	....
May, 1887	4,152.94	1,523.38	357.30	....
June, 1887	5,294.45	1,926.59	452.50	....
Second course:				
June, 1887	5,358.94	1,537.71	....	462.8
Total	33,302.85	10,335.86	2,395.48	462.8
Previously laid	74,170.00	23,280.00	7,667.00	
Grand total	107,472.85	33,615.86	10,062.48	462.8

Mr. A. S. Cooper, who has been the resident engineer during the year, has rendered most faithful and valuable service.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Fernandina, Fla., from January 1, 1875, *to December* 31, 1885.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	212	117,363	4,192	47	10,379	359	12	7,437	135	271	135,179	4,686
1876	210	141,354	4,749	25	4,893	179	28	9,232	249	263	155,479	5,177
1877	150	100,581	3,343	31	8,768	217	40	12,547	404	221	121,896	3,964
1878	183	120,845	3,900	17	3,985	101	22	8,294	215	222	133,124	4,216
1879	205	133,620	4,138	28	10,634	252	10	5,639	126	243	149,293	4,216
1880	270	146,722	4,470	34	22,396	598	22	9,463	240	326	168,581	5,308
1881	273	171,548	4,186	17	11,899	314	24	11,593	271	278	195,040	4,771
1882	239	146,383	3,279	16	9,056	242	15	6,639	151	270	162,078	3,672
1883	183	96,937	2,453	6	1,769	43	14	5,229	137	203	103,935	2,633
1884	176	105,061	2,864	3	865	21	10	4,029	88	189	109,955	2,973
1885	169	111,698	3,131	7	999	47	22	9,785	210	198	122,482	3,388
1886	205	147,418	4,014	7	2,112	53	15	5,187	146	227	154,717	4,213

CLEARED.

Year.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	229	121,028	4,303	31	8,239	228	15	5,343	212	275	134,610	4,743
1876	244	161,154	5,058	21	6,040	147	26	9,002	269	291	166,196	5,474
1877	165	106,015	3,590	24	6,340	166	42	13,741	412	231	126,696	4,168
1878	195	124,883	4,086	19	4,911	123	26	9,080	236	240	138,874	4,445
1879	175	129,654	4,079	31	11,067	258	12	8,016	164	218	148,737	4,501
1880	244	155,659	4,505	31	14,207	327	24	10,292	240	299	180,968	5,072
1881	204	138,598	3,730	41	22,007	506	31	15,335	351	276	175,940	4,587
1882	217	136,666	3,166	39	15,497	370	31	14,962	321	287	167,125	3,857
1883	153	85,815	2,245	32	8,925	210	24	9,413	231	209	94,153	2,686
1884	178	104,462	2,688	27	8,831	176	15	6,488	158	210	119,781	3,022
1885	185	112,936	2,970	33	10,251	249	21	9,393	221	239	132,580	3,440
1886	214	153,092	4,208	27	9,072	200	26	9,817	299	267	171,981	4,707

Arrivals and clearances of vessels, and commerce at Fernandina, Fla., etc.—Continued.

COMMERCE.

Year.	Value of exports.		Value of imports.		Total commerce.	Duties collected.
	Foreign.	Coastwise.	Foreign.	Coastwise.		
1875	$209, 791	$1, 109, 979	$14, 304	$755, 718	$2, 089, 792	$1, 817. 84
1876	226, 076	1, 170, 240	46, 479	1, 131, 032	2, 573, 827	2, 181. 40
1877	310, 225	676, 855	19, 304	1, 146, 363	2, 152. 747	2, 376. 00
1878	248, 000	780, 607	8, 142	872, 234	1, 908, 983	2. 090. 00
1879	275, 470	921, 368	11, 038	1, 360. 432	2, 568, 308	3, 424. 00
1880	257, 780	667, 092	3, 676	1, 365, 857	2, 294, 405	7, 8[illegible]8. 00
1881	292, 100	1, 064, 394	11, 791	1, 736, 546	3, 104, 831	8, 183. 00
1882	292, 400	1, 342, 421	45, 792	1, 536, 588	3, 217, 201	36, 590. 00
1893	248, 600	2, 573, 010	11, 229	2, 262, 755	5, 095, 594	5, 566. 00
1884	173, 600	1, 164, 462	1, 874	1, 738, 620	3. 078, 556	1, 331. 00
1885	214, 726	2, 134, 541	4, 189	1, 502, 544	3, 855, 991	1, 451. 28
1886	191, 595	2, 843, 000	590	1, 625, 000	4, 660, 189	808. 00

W. A. MAHONEY,
Collector.

Arrivals and clearances of vessels, and commerce, at Saint Mary's, Ga., from January 1, 1879, *to December* 31, 1886.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1879	53	16, 773	378	6	2, 303	54	14	5, 155	143	73	24, 231	475
1880	30	8, 982	202	2	694	17	16	6, 409	185	48	16, 085	404
1881	22	7, 541	156	6	2, 491	54	25	11, 292	290	53	21, 324	500
1882	28	10, 504	196	1	371	7	15	5, 723	146	44	16, 598	347
1883	26	9, 596	182	3	1, 207	24	6	2, 112	44	35	12, 915	250
1884	32	11, 294	224	1	539	9	6	2, 334	57	39	14, 065	290
1895	40	13, 042	280	1	396	8	5	2, 028	52	46	15, 466	340
1886	20	7, 882	140	1	321	7	6	2, 085	56	27	10, 288	203

CLEARED.

Years.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1879	53	16, 773	378	10	3, 577	83	14	5, 155	143	77	25, 505	604
1880	30	8, 982	202	3	1, 150	27	12	4, 979	132	45	15, 111	361
1881	22	7, 541	156	7	3, 362	68	29	12, 463	323	58	23, 336	547
1882	28	10, 504	196	4	1, 567	32	18	6, 791	175	50	18, 862	403
1883	26	9, 596	182	3	1, 207	24	6	2, 112	46	35	12, 915	252
1884	82	11, 294	224	2	1, 097	19	6	2, 234	57	40	14, 625	300
1885	40	13, 042	280	3	1, 195	25	4	1, 595	42	47	15, 732	347
1886	20	7, 882	140	5	2, 312	40	5	1, 646	45	30	11, 840	210

COMMERCE.

Years.	Value of exports.	Years.	Value of exports.
1879	$82, 491	1883	$26, 902
1880	70, 411	1884	22, 517
1881	149, 333	1885	27, 127
1882	47, 216	1886	36, 520

E. A. McWHORTER,
Collector.

N 15.

IMPROVEMENT OF THE INSIDE PASSAGE BETWEEN FERNANDINA AND ST. JOHN'S RIVER, FLORIDA.

Appropriations for the improvement of this route, aggregating $78,000, were made at various times between the years 1828 and 1838. A further appropriation of $10,000 was made in 1874, and two others, of $7,000 each, by the acts approved March 3, 1879, and June 14, 1880, respectively.

Only $2,565.55 of the amount last appropriated had been expended when the work was stopped.

As suggested in previous reports, the recently completed direct line of railway between Fernandina and Jacksonville and the improvement of the bar at the mouth of St. John's River afford passengers and freight a choice between transit by rail and transit by sea and river by coasting steamers, and the necessity for continuing the improvement of this inside passage is therefore not urgent at the present time; still the inside passage between Savannah and Jacksonville, which actually continues far into the interior of Florida by means of the St. John's River, may be considered a valuable water route for many purposes. Its importance in the case of the United States becoming involved in war with a maritime power has been pointed out in former reports. Its improvement, when undertaken, should be on a liberal scale.

The following appropriations have been made for this work since 1874:

By act of Congress approved June 23, 1874	$10,000
By act of Congress approved March 3, 1879	7,000
By act of Congress approved June 14, 1880	7,000
Total	24,000

The total expenditures since 1874, including the cost of survey, were $19,565.55.

The inland route is partly in the collection district of Fenandina and partly in that of Saint John's, of which Fernandina and Jacksonville are the respective ports of entry.

Money statement.

July 1, 1886, amount available	$4,434.45
July 1, 1887, amount available	4,434.45

N 16.

PRELIMINARY EXAMINATION FROM DOBOY ISLAND TO DOBOY BAR, GEORGIA.

UNITED STATES ENGINEER OFFICE,
New York, December 11, 1886.

GENERAL: By Department letter dated September 27, 1886, I was informed that the river and harbor act of August 5, 1886, provides that a preliminary examination should be made "from Doboy Island to Doboy Bar, Georgia," and that this work had been assigned to my charge. I was further instructed to report, after completing the examination, whether the locality named is considered worthy of improvement, with a view of having it surveyed.

The examination here ordered was made under my direction during last month, and I have the honor to submit the following brief report:

Doboy Island is situated at the mouth of Darien River, the northerly main branch of Altamaha River, about 12 miles below the town of Darien. The village of Doboy is located upon the western shore of the island; vessels from the port of Darien complete their cargoes here. Doboy Island is separated from Doboy Sound by Commodore Island.

The channel of entrance across Doboy Bar is substantially a southeasterly prolongation of the axis Doboy Sound. I have already stated in my last annual report of operations for improving Altamaha River, Georgia, that shoaling has taken place on the bar since 1875, the draught of vessels that could cross it being reported to have diminished from 22 feet in that year to from 18 to 18½ feet in 1885.

By comparing the latest Coast Survey Chart (1886) of Doboy Bar with the results of the recent examination, the principal changes noted are as follows:

Formerly the channel crossed the bar proper in two branches; the north branch running nearly due east, had a minimum low-water depth of 8 feet; the south branch, running in a more southerly direction, had practicable low-water depths of 14 feet. The mean rise and fall of the tide on the bar is 7.2 feet.

The observations taken in November, 1886, show that the north channel has generally maintained its direction, but has deepened about 2½ feet, and the distance between its inner and outer 14 foot low-water curves has diminished about 1,850 feet. The outer portion of the south channel has moved about 1,000 feet south of its former position; its inner portion has not changed, but the present minimum low-water depth is only 11.1 feet; a reduction of 3 feet since 1868.

The "North Breakers" Shoal has moved to the south and west, across the old south or main channel of entrance; at places of 15 to 16 feet depth some eighteen years ago there are now found only 8 or 9 feet. A new channel seems to be forming, however, to the north of and about 2,000 feet from it; the 14-foot curve has pushed here about 3,000 feet seawards, and the distance between the easterly end of this pocket and the outer 14-foot curve is at present only 1,400 feet.

Lieutenant Carter states that for vessels engaged in the coasting trade, whose average draught is about 15 feet, the present depth of water on the bar is sufficient, but in carrying lumber and timber it is often desirable to load to 18 or 20 feet, or even to greater depths. The bar in its present condition will not afford such draughts.

The town of Darien has about 2,000 inhabitants. It is an important shipping port, especially for the lumber coming down the Altamaha River. Shipping merchants have repeatedly complained of the want of sufficient depth on Doboy Bar, preventing vessels of deep draught to take full cargoes at Doboy, compelling them to load at increased cost at Sapelo, Saint Simon's, and Brunswick, thus putting them at a disadvantage in their competition with other ports in the neighborhood. Statistics of the commerce of Darien were given in my report of a survey of Darien Harbor, dated January 30, 1885, printed as Appendix N 16, Annual Report of the Chief of Engineers for 1885, and in House Ex. Doc. No. 260, Forty-eighth Congress, second session, also in my annual report of the improvement of Altamaha River, Georgia, for the fiscal year ending June 30, 1886, while others are given in letters and statements inclosed in Lieutenant Carter's report of the recent examination.

I am not prepared, however, to recommend that a survey of Doboy Bar be made with a view of designing a project for its permanent improvement. Suitable works for that purpose would undoubtedly be quite expensive, and their cost would not, in my opinion, be justified by the present magnitude of the interests to be subserved thereby.

By the river and harbor act of August 5, 1886, an appropriation of $20,000 was made "for improving Altamaha River, Georgia, half of which to be used on Doboy Bar, or so much thereof as may be necessary." I coincide with the suggestion made by Lieutenant Carter, that a small amount of the appropriation be expended in hydraulic excavation or propeller sluicing, so as to create a greater depth of water on the bar, improving the new channel which seems to be in process of formation, as stated above.

I recommend, therefore, that so much of the sum of $10,000, allotted for Doboy Bar, as may be deemed necessary, may be expended for its improvement by methods here indicated.

The report of First Lieut. O. M. Carter, Corps of Engineers, with letters addressed to him, and a chart of the examination of Doboy Bar, are transmitted herewith.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., December 6, 1886.

COLONEL: In compliance with your instructions of the 8th ultimo, I have the honor to submit the following report of a preliminary examination from "Doboy Island to Doboy Bar."

Doboy Island is situated upon the coast of Georgia, about 50 miles by the coast line south of the Savannah River. It lies at the mouth of Darien River, about 12 miles measured along the channel, below the village of Darien, and is separated by Commodore Island from Doboy Sound.

Darien River is the northerly main branch of the delta portion of the Altamaha. Through it passes the greater portion of the Altamaha River commerce. Upon the western shore of Doboy Island is situated the village of Doboy, where vessels shipping from the port of Darien receive their deep-draught loads. From Doboy to the sea the only obstruction to navigation is Doboy Bar.

The only known survey of this bar is that made by the United States Coast Survey in 1868, from which the shore-lines and soundings in black on the chart, forwarded herewith, are taken. At that time the bar, the general direction of which has not since changed, extended ESE. from the southern end of Sapelo Island for a distance of about 3¼ miles, then in a southerly direction about parallel to the coast line for nearly 3 miles, connecting with the shoals which extended ESE. from the northern end of Wolf Island. From the mouth of Doboy Sound, between Sapelo and Wolf islands, where low-water depths of from 4 to 6 fathoms were found, the channel extended ESE. between the sand spits forming the shore-arms of the bar, for a distance of about 2¼ miles, then divided and crossed the bar in two branches; the northern one having a direction about E. by N. with minimum low-water depths of 8 feet, and the southern one extending SE. ¼ S. about 1¾ miles, and then E. by S. to sea, with minimum low-water depths of 14 feet. The mean rise and fall of tide being 7.2 feet, vessels drawing 20 feet were able to cross the bar in calm weather at mean high water, and it is claimed that on high water of spring tides vessels of 22 feet draught have been taken from Doboy to the sea.

Since the date of that survey the bar has shoaled greatly. A preliminary examination of this bar, from the bell-buoy seaward, was made by me in November, 1886, and some of the soundings taken then are shown in red on the accompanying chart. By referring to this it will be seen that the north or slew channel has deepened about 2¼ feet, while the south or main channel has shoaled about the same amount.

The general direction of the north channel has not changed, but the distance along that line between the inner and outer 14-foot mean low-water curves has diminished about 1,850 feet; the inner pocket having shifted to the east, and moved seaward about 1,500 feet, while the outer curve has moved shoreward about 350 feet. The south or main channel has shoaled about 3 feet since 1868, its present minimum low-water depth being 11.1 feet. From 1868 to 1879 the direction of this channel did not sensibly change.

At present its outer portion is about 1,000 feet south of its former position. The inner portion has not changed.

The "North Breakers" Shoal has moved to the south and west, and pushed entirely across the old channel, separating the inner and outer 14-foot mean low-water curves by a distance of about 2,000 feet. On the line of the old channel the present depths are from 8 to 9 feet as compared with 15 and 16 feet eighteen years ago. About 2,000 feet to the north of this, however, the depth of water is increasing, and a new channel is in process of formation. Beginning at a point about 1,000 feet to the north of black Bouy No. 1, the 14-foot mean low-water curve has extended ESE. about 3,000 feet, the distance from the end of this pocket to the 14-foot curve on the outer slope of the bar being at present only 1,400 feet.

The material composing this bar is a mixture of fine sand and fragments of shells, and when loosened and thrown into suspension is easily moved.

For vessels engaged in the coasting trade, whose average draught is about 15 feet, the present depth of water on the bar is sufficient, but in exporting lumber and timber it is often desirable to load to 18 or 20 feet, or even to greater depths.

I submit the following letters and extracts:

FROM LETTER OF MR. R. K. WALKER, TIMBER MERCHANT.

DARIEN, GA., *September* 16, 1884.

DEAR SIR: * * * Our bar at Doboy, before and a considerable time after 1860, admitted vessels of 22 feet draught, and this fact, well known abroad, gave to our port the reputation of being one amongst the best and safest ports on the southern coast. Vessels were in consequence easily and cheaply secured, thus giving an impetus to the timber industry, which quickly made Darien rank as one of the foremost timber exporting ports, in a position to compete with any other.

Gradually, however, the bar has so filled up that now vessels drawing 18 or 19 feet of water can not be carried out without touching, unless the sea is perfectly calm. This has compelled the merchants here to load their large vessels at such points as Sapelo, Saint Simon's, and Brunswick, thus, in the first place, depriving our port of such pecuniary benefits as naturally would accrue to it from the presence of such vessels, besides putting merchants in a disadvantageous position to compete with other markets, on account of extra cost of drifting timber to such points, and other inconveniences and extra expenses attending such a course. If, therefore, this filling up process is allowed to go on undisturbed, it means certain death to Darien as a shipping port, and to ship profitably via Brunswick or Saint Simon's can not be done on account of the extra cost consequent upon transporting timber such a distance.

In regard to the supply of timber along the river, I will say from personal knowledge that it is almost inexhaustible, and although there is not much in the immediate vicinity of the river, means of getting it down to the river-side can be arranged sufficiently cheap to prove profitable to the cutter if our port is again put on its former footing.

* * * * * * * *

Yours, respectfully,

R. K. WALKER.

SPALDING KENAN, Esq.,
Mayor.

LETTER FROM HILTON TIMBER AND LUMBER COMPANY.

DARIEN, GA., *November* 18, 1886.

SIR: Understanding that a survey of Doboy Bar is contemplated for the purpose of determining whether improvements can be made and are required to facilitate the business of this port, we take the liberty of addressing you upon this subject.

We have no hesitancy in declaring that the deepening of Doboy Bar is much needed, and if a deeper depth of water can be had the business of the port will be enhanced.

We have known vessels drawing 21 and 22 feet of water to pass out over the bar with safety. During the past year we have had vessels loaded by us drawing 18 and 18¼ feet of water detained, some of them two months, on account of low depth of water upon the bar.

This port does a considerable foreign trade, and the class of vessels engaged in this business are generally of deep draught, and we dare not charter vessels to load at this port drawing over 18 feet; hence when we take large orders requiring deep-draught vessels we are compelled to load them either at Sapelo Sound or at Saint Simons. In loading vessels at these points we are compelled to tow the cargoes to these points, which involves an additional and greater expense, risk, and inconvenience. So far as this company is concerned, we feel very much interested in the improvement of the Doboy Bar, and trust the Government will see fit to do something in that direction.

With the bar improved we would feel in a condition to take orders, which we would refuse now, on account of the additional expense and great inconvenience which attend the shipments at the adjacent points, before mentioned; hence we feel satisfied an increased depth of water on our bar would materially increase the business done at this port.

Very respectfully,

HILTON TIMBER AND LUMBER COMPANY.
ROBERT P. PAUL,
Secretary and Treasurer.

Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

LETTER FROM ROBERT HUNTER AND COMPANY, TIMBER MERCHANTS.

DARIEN, GA., *November* 18, 1886.

DEAR SIR: By request we hereby submit our reasons for the decrease of the timber trade of this port.

During the season 1883–'84 we shipped about 12,000,000 superficial feet, and season 1884–'85 between 9,000,000 and 10,000,000 superficial feet, and season 1885–'86 between 7,000,000 and 8,000,000 superficial feet. Out of these 8,000,000 feet about 3,000,000 were shipped via Saint Simons, while in the previous years an occasional cargo only was shipped from there. The vessels loaded at Saint Simons during 1885–'86 were sent there simply because there was not sufficient water on Doboy Bar to admit them. It is decidedly more expensive to load vessels at Saint Simons, first on account of the transportation of timber to that place being almost doubly expensive, that is, on a vessel that carries 500,000 superficial feet the cost of drifting the timber to Saint Simons would be $130, while to Doboy it would only cost $75. Then there are other costs which could be obviated were vessels at Doboy; for instance, the expense of going to Brunswick to clear such vessels, and the loss of time attending same. But the above are minor considerations. It is a fact that under ordinary circumstances timber can be drifted from Darien to Doboy in 2 tides. To Saint Simons it takes at least three days. This loss of time is of course an important consideration when a question of demurrage arises. Again, the broad and straight stream to Doboy makes it possible to send timber there in almost any kind of weather, while a little spell of rough weather makes it positively unsafe to start a drift to Saint Simons, on account of the many narrow and winding parts that have to be passed through in going there.

All these disadvantages certainly help to handicap shippers at this point, and it is obvious that in consequence not only no stimulus, but a decided check is given to the trade.

We do not forget to make due allowance for the general trade depression of the last two or three years when we assert that to the necessity of shipping timber and lumber via such far-off points as Sapelo and Saint Simons may be attributed the glaring decrease of shipments from this port.

We are, dear sir, yours, faithfully,

ROBERT HUNTER & CO.
Per R. MUNSON, *Attorney.*

Lieut. O. M. CARTER.

COMMERCIAL STATISTICS OF THE PORT OF DARIEN, GEORGIA.

Exports of timber and lumber (pitch pine) as per tabulated report.

Total value foreign shipments from January 1, 1875, to January 1, 1886 (583,316,741 superficial feet)	$7,090,283.00
Total value coastwise shipments from January 1, 1875, to January 1, 1886 (178,729,300 superficial feet)	2,949,730.90

Rice.

Coastwise shipments:	
Total value from January 1, 1875, to January 1, 1886	$924,000.00
Average annual value	84,000.00

The figures given above are the result of careful investigation, and due consideration has been given to the partial failure of the crops of certain years and to the fluctuations of prices.

Naval stores.

Coastwise shipments from 1880 to and including 1885.................... $305,000.00

In the year 1880 the value of naval stores shipments amounted to $12,000. The operations have gradually been extended until in 1885 the value of shipments, from reliable figures, amounted to $66,000. In 1886 it is estimated they will reach $85,000. Shipments are made in small sailing vessels and in steamers.

Cypress.

Prior to 1886 but little attention was given to this wood. Some enterprising Northern gentlemen (the Messrs. Van Gilder & Sons), discovering its abundance along the Altamaha, have now erected a mill at Darien expressly for the manufacture of cypress. This has given a decided stimulus to the industry and it bids fair to beome flourishing ere long. Small parcels of this wood have been shipped for many years. The first complete cargo was shipped during 1886 and before the present year ends two more cargoes will be shipped.

Hardwoods.

Coastwise and foreign shipments from January 1, 1875, to January 1, 1886.. $35,000.00

Considering the great quantities of the various kinds of hardwoods that may be found along the Altamaha, the trade in these woods has not been developed to the extent it deserves. Few entire cargoes have been shipped, but small parcels of oak, ash, hickory, etc., are frequently sent along with pine cargoes. The great obstacle in the way of extensive shipments of oak is the costly and annoying transportation to Darien, it being necessary to attach it to pine or lighter woods to prevent it from sinking. Those of our business men who have any experience in this line are of the opinion that in order to engage in the shipment of oak a liberal investment of capital for flats, tow-boats, etc., would be necessary, but the unsatisfactory state of affairs produced by the insufficiency of water on the bar does not tend to encourage any such investment.

Hides.

Total value shipments from January 1, 1875, to January 1, 1886........... $11,000.00
Average annual value.. 1,000.00

About 500 hides have been exported annually, coastwise.

Brick factory.

Messrs. Toad & Huntington, out of a clay brought from Sansavilla, about 25 miles from Darien, manufacture an excellent brick. The clay is brought from Sansavilla in flats, and the brick is manufactured here. So far the manufacture has been regulated by the local demand, but the gentlemen who have the enterprise in hand are now prepared to extend their operations. The quality of the clay has been pronounced superior by experts and the supply is practically inexhaustible. Little or nothing was done in this line prior to 1886.

Coastwise imports not entered in custom-house.

Total value from January 1, 1875, to January 1, 1886.................. $3,965,000.00

Number of steamers (coastwise) touching at Darien, etc.

During the years 1875, 1876, 1877, 1878, 1879, and 1880, the average annual value of coastwise imports amounted to $390,000.

The years 1881, 1882, 1883, 1884, and 1885 show an average annual value of $325,000.

During the first six years the number of steamers trading between points up the river, Brunswick, Savannah, and Darien, touching at Darien on an average 240 times a year, with a gross average tonnage of 63,000 tons per annum. Now about 150 landings are made, and the average tonnage amounts to about 40,000 annually.

Farm products.

Annual average value.. $7,000.00

All farm products are disposed of at home.

Value of the stevedore business.

1875	$92,787	1882	$97,828
1876	29,057	1883	102,826
1877	139,275	1884	116,170
1878	125,745	1885	92,189
1879	104,550		
1880	161,512		
1881	151,258	Total value for the eleven years	1,313,197

VALUE OF THE TONNAGE BUSINESS.

1875	$19,875	1882	$24,548
1876	24,766	1883	22,987
1877	27,452	1884	22,151
1878	25,165	1885	18,439
1879	21,400		
1880	23,763		
1881	32,957	Total value for the eleven years	263,503

VALUE OF THE PILOTAGE BUSINESS.

Pilotage on foreign vessels for last eleven years	$109,509
Pilotage on coastwise vessels for last eleven years	82,250
Total	191.759

GENERAL REMARKS REGARDING THE COMMERCE OF THE PORT OF DARIEN, GEORGIA.

The timber trade.—So far as inclosed official figures of exports tell the tale, our timber trade is on the decrease. Actually it is not. As much timber as ever comes down to Darien from the interior, but the shallowness of water on our bar makes it necessary to ship a large part of our timber to Sapelo and Saint Simons. While the cost of sending timber from Darien to Doboy is from 12½ to 15 cents per 1,000 feet, the cost of sending it to Sapelo and Saint Simons is from 25 to 30 cents per thousand. It is easy to see that this disadvantage alone will do much to exclude us from competition with other pitch-pine ports who have no such disadvantages to contend with. Such shipments also being cleared through the custom-houses of Savannah and Brunswick, go to swell their exports, and Darien, in consequence, finds it a hard matter to secure anything like the recognition she deserves. The presence of such vessels in our own harbor would materially increase our general trade and add to the importance of the port. While so far all these disadvantages have not dealt any serious blow to the interior timber trade, they certainly have prevented its natural growth and with it the growth of our commerce generally.

For the last five years from 15 to 25 vessels of a large class have annually loaded with Darien timber at Sapelo and Saint Simons, but the quantities and values of these cargoes are recorded in the custom-houses of Savannah and Brunswick and claimed as amongst their exports.

The figures submitted in this report are strictly shipments from our own harbor.

Timber shipments from port of Darien, Ga., from January 1, 1875, *to January* 1, 1885.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
1875	41,447,024	$557,524	10,992,600	$181,377.00	52,439,624	$738,901.00
1876	60,762,000	735,099	8,370,000	138,105.00	69,132,000	878,204.00
1877	64,378,000	776,856	11,888,100	196,153.65	76,266,100	973,009.65
1878	59,697,124	716,365	7,057,800	116,453.70	66,754,924	832,818.10
1879	47,217,818	566,613	12,646,800	208,672.20	59,864,618	775,285.20
1880	74,612,520	895,350	15,368,500	253,578.60	89,981,020	1,148,928.60
1881	65,420,876	785,060	25,642,800	423,106.20	91,063,676	1,208,156.20
1882	36,639,379	439,672	30,688,200	506,355.30	67,327,579	946,027.30
1883	42,385,000	508,620	22,517,100	371,522.15	64,902,100	880,152.15
1884	50,656,000	607,872	18,573,300	306,459.45	69,229,300	914,331.45
1885	40,101,000	501,262	14,984,100	247,937.65	55,085,100	749,199.65
Total	583,316,741	7,090,283	178,729,300	2,949,730.90	762,046,041	10,040,013.90

COMMERCE.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1,621,904	$5,600	$11,806.72
1881	1,137,496	3,356	18,980.02
1882	1,073,008	1,025	11,254.19
1883	969,834	2,334	11,067.37
1884	1,038,185	11	9,688.20
1885	860,500	....	2,359.01

R. W. Grubb,
Deputy Collector, port of Darien.

First Lieut. O. M. Carter,
Corps of Engineers, U. S. A.

Arrival and clearances of vessels at Darien, Ga., from January 1, 1875, *to January* 1, 1886.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draught.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	*Feet.*
1875	77	28, 053	641	....	....	....	92	47, 600	1, 198	169	75, 663	18, 215	22
1876	65	23, 105	611	....	....	....	124	70, 368	1, 897	189	93, 473	2, 508	21
1877	104	24, 827	1, 257	3	674	22	99	50, 913	1, 231	206	166, 414	2, 510	20
1878	61	29, 264	641	2	1, 051	20	126	60, 109	1, 620	187	90, 424	2, 289	20
1879	58	23, 275	487	3	1, 199	25	115	57, 710	1, 407	176	82, 184	1, 919	19½
1880	66	21, 539	489	1	668	13	134	68, 072	1, 608	201	90, 279	2, 110	19½
1881	101	40, 613	849	3	1, 220	29	162	84, 456	1, 991	266	126, 295	2, 869	19½
1882	117	48, 208	999	1	453	9	90	51, 421	1, 155	208	100, 082	2, 163	19
1883	95	38, 173	815	....	....	....	93	49, 790	1, 135	188	87, 963	1, 950	19
1884	81	34, 412	714	2	606	16	92	50, 178	1, 133	175	85, 196	1, 863	19
1885	78	27, 763	682	2	652	16	80	42, 587	975	160	71, 002	1, 673	18½

CLEARED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draught.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	*Feet.*
1875	22	12, 214	328	11	4, 035	97	104	55, 759	1, 372	137	72, 028	1, 797	22
1876	39	9, 300	270	4	1, 553	32	180	87, 489	2, 263	223	98, 342	2, 565	21
1877	44	13, 209	314	4	842	21	169	92, 795	2, 154	217	106, 846	3, 489	20
1878	28	7, 812	181	6	3, 009	62	149	83, 385	1, 947	183	94, 236	2, 190	20
1879	40	14, 052	301	7	2, 765	57	125	65, 433	1, 538	172	82, 250	1, 896	19½
1880	55	17, 076	393	7	8, 589	72	168	84, 172	2, 016	230	104, 837	3, 481	19½
1881	80	28, 492	617	8	3, 120	70	184	95, 353	2, 164	272	126, 965	2, 851	19½
1882	93	34, 095	709	6	1, 962	46	115	63, 525	1, 434	214	99, 585	2, 189	19
1883	66	25, 019	519	9	3, 533	72	108	56, 411	1, 340	183	84, 963	1, 931	19
1884	59	20. 637	457	11	3, 977	85	119	66, 337	1, 478	189	90, 951	2, 020	19
1885	46	16, 649	339	8	3, 354	62	98	52, 742	1, 198	152	72, 745	1, 509	18½

The foreign shipments of timber and lumber for 1885 were 40,101,000 feet, valued at $500,000.

To permanently improve Doboy Bar would require the construction of contracting works of great length and cost, and from all of the foregoing I am of the opinion that the present and prospective demands of commerce are not such as to warrant the expenditure of such a sum of money.

I think, however, that a small amount can be so expended in hydraulic excavating or propeller sluicing as to give a greatly increased depth of water on the bar and a reasonably permanent channel, and I am of the opinion that, to this extent, the channel from "Doboy Island to Doboy Bar" is worthy of improvement. No survey is needed.

The population of Darien is about 2,000, and of Doboy about 400.

Doboy is in the collection district of Brunswick. Darien is the nearest port of entry. Sapelo is the nearest light-house.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

APPENDIX O.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF FLORIDA.

REPORT OF CAPTAIN WILLIAM M. BLACK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Saint John's River, Florida.
2. Volusia Bar, Florida.
3. Upper Saint John's River, Florida.
4. Survey of entrance to harbor of Key West, Florida.
5. Caloosahatchie River, Florida.
6. Pease River, Florida.
7. Manatee River, Florida.
8. Tampa Bay, Florida.
9. Withlacoochee River, Florida.
10. Harbor at Cedar Keys, Florida.
11. Suwanee River, Florida.
12. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS.

13. Tampa Bay, Florida, including Hillsborough River up to the city of Tampa.
14. Charlotte Harbor, including San Carlos Bay, Florida.
15. Clearwater Harbor, including Anclote and Saint Joseph's bays and the Narrows into Boca Ciega Bay, Florida.
16. Wakulla River, Florida, from its mouth to Wakulla Spring.
17. Channel from Haulover, on Indian River, to Gilbert's Bar, Florida.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., July 30, 1887.

SIR: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 1.

IMPROVEMENT OF SAINT JOHN'S RIVER, FLORIDA.

Operations for improving the channel over the bar at the mouth of the Saint John's River, Florida, have been carried on under contract, and in accordance with the larger of two projects submitted to the Chief of Engineers by the officer then in charge, June 30, 1879, and printed as part of Appendix I 7, Annual Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The plan of improvement essentially consists in the construction of two low jetties, built of riprap stone, supported by a foundation mattress or platform of logs, with a mattress hearting wherever found practicable, to reduce the cost of the work.

Of the two plans discussed, which differ from each other in magnitude and probable effects, the more comprehensive has been adopted. This plan provides for the construction of two long jetties starting from the opposite shores of the entrance and extending seaward across the bar. It was intended thereby to establish a mid-channel depth of 15 feet at mean low water. The usual available low-water depth over the bar in its unimproved condition was 6 feet, more or less, with a mean rise and fall of tides of about 5 feet. The cost of this project was estimated at $1,306,409.

In order to secure the full benefit of an increased low-water depth of the bar, as contemplated by the project, it will be necessary to improve some defective reaches of Saint John's River between the bar and the city of Jacksonville. The cost of this has been approximately estimated at $120,000.

These additional works are considered to be properly the subject of a special project and appropriation. If it should be finally decided to include them under the general head, "Improvement of Saint John's River," the estimate of the cost of the project given above must be correspondingly increased.

Since the adoption of the existing plan of improvement of June 30, 1879, five appropriations have been made by Congress for the work, aggregating $675,000. Previously (since 1865) an aggregate sum of $57,476.38 was expended in dredging for the temporary improvement of the bar channel.

For making the preliminary surveys and preparing the project, the sum of $2,523.74 was expended.

SUMMARY OF OPERATIONS PRIOR TO JUNE 30, 1886.

South Jetty.—The foundation course or apron was laid to an aggregate length of 6,715.4 feet. Of this, the shore branch is 874 feet long, with a bearing of north 46 degrees 45 minutes east. The main line begins at a point 70 feet back from the outer end of the shore branch, and runs as follows, viz:

	Feet.
Range 2 north, 74° 54′ east	3,538
Range 3 north, 75° 54′ east	328
Range 4 north, 77° 41′ east	400
Range 5 north, 79° 41′ east	400
Range 6 north, 81° 41′ east	400
Range 7 north, 83° 41′ east	400
Range 8 north, 85° 41′ east	373

On ranges 1, 2, 3, and a part of 4, the width of apron varies from 20 to 87 feet. In ranges 5, 6, 7, and 8, the width was increased to from 110 to 120 feet, on account of the rapid current already developed along the axis of the jetty. In all, the apron is covered with from 12 inches to 15 inches of stone. At different points along the second range the following additional courses have been laid, viz: A second course, 3,209 feet long; a third, 2,729 feet long; a fourth, 1,544 feet long; a fifth, 1,317 feet long; a sixth, 903 feet long; a seventh, 127 feet long; an eighth, 134 feet long; and a ninth, 40 feet long. In general the mattresses of each course were 8 feet narrower than those of the course below.

Eight low spur-jetties were constructed, four on each side of the jetty, opposite to each other. They are located at distances of from 500 to 1,800 feet from the angle of the junction of the main line with the shore branch. These spurs are formed of two courses of mattresses, the lower ones projecting from 81 to 98 feet beyond the edges of the apron of the main line. Those laid on the north side are 75 feet wide, and those on the south side 100 feet wide. The original foundation course of the main line was widened to arrest the destructive action of very strong currents developed alongside of and across the work. A revetment or apron of mattresses, varying in width from 40 to 100 feet, beginning at the low-water mark and extending 2,652 feet, was laid on the south side.

The foundation was still further broadened by placing a revetment or apron on the north side similar to that on the south. This revetment began at the second spur from the shore, and extended seaward a distance of 1,703 feet, the width varying from 70 to 100 feet.

Between spurs 2 and 3, upon a length of 300 feet, there seems to be less stability than in the rest of the jetty. Here the greatest settlement has taken place; and as it had been built up as a wall, with steep sides, it was further strengthened by a sort of buttress composed of log mattresses and riprap stone, in all respects similar to the construction of the jetty. This buttress leans or abuts against the jetty for a distance of about 120 feet, parallel to the axis, and is formed of six courses of mattresses, the lower course being 35 feet wide and the top course 14 feet.

For holding the mattress work in place and in building up the south jetty, the amount of riprap stone employed from the beginning of operations to June 30, 1886, aggregated 66,373.43 cubic yards.

North jetty.—The total length of this jetty in place was 4,330.5 feet. The mattresses were from 40 to 100 feet wide, in one course, and laid in a single range bearing south 73 degrees east.

Up to June 30, 1886, the total expenditures for both jetties, including outstanding liabilities, amounted to $523,065.72.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

In act approved August 5, 1886, $150,000 were appropriated for continuing this improvement.

Great difficulty has been experienced in connecting the north jetty with the dry beach. In 1882 the first mattresses of the jetty were laid at the low-water line. In 1883 this line had receded 70 feet, and a channel having a maximum low-water depth of 7 feet had formed around the inner end of the jetty. In 1885 the jetty was extended shorewards 905 feet across this channel with mattresses varying in width from 50 to 65 feet. The inner end of the jetty as thus built was 9 feet above mean low-water level. In June, 1886, this end had fallen to 15 inches above mean low water, and at high water was completely submerged. When operations commenced in the winter of 1887 a shallow low-water channel had formed around the end of the jetty. As so little success had attended the use of the ordinary mattresses at this point, it was determined to make connection with the shore by a dike formed of two rows of piles 6 feet apart, each row carrying two lines of waling strips, and the two rows being firmly connected by cross-bracing. This dike was to be filled with a hearting of stone, resting on a log and brush mattress. The piles were to be of palmetto wood, and were to be sunk to a depth of 15 feet.

On November 9, proposals for building this dike were opened after due advertisement. A contract for the work was entered into with Mr. James A. Bryan, the lowest bidder, at the rate of $7.22 per linear foot of finished dike. This was approved by the Chief of Engineers November 29, 1886. Work under the contract began January 28, 1887, and the dike was accepted June 24. The piles were sunk to the required depth by the use of the water-jet, assisted by light blows of a pile-driver.

After completion the dike was found to be too porous. The tidal currents passed through it, cutting out the sand and threatening to undermine the entire structure. The log mattress was not sufficiently flexible to follow closely the irregularities of the sand, and great holes were eroded under the structure from side to side. Measures were at once taken to stop this action by the use of bundles of brush weighted with stone. These were placed in the holes along the dike, and short wing-dams were thrown out from the sides. At the same time the interstices between the stones in the hearting were filled with oyster shells. These measures are proving successful. For half its length the sand has already built up along the dike, and the permanence of the structure is insured. The level of the sand on the north side is only about 12 inches below the level of the top of the dike, and is about 2 feet higher than on the south. It is proposed to continue the building out of the beach until the inner end of the jetty proper is reached.

On December 11, after due advertisement, proposals were opened for continuing the construction of the jetties proper. Mr. Rittenhouse Moore, of Mobile, Ala., was the lowest bidder, and a contract was entered into with him for furnishing mattresses in place at 45 cents per square yard, and stone in place at $2.45 per ton of 2,000 pounds. This contract was approved by the Chief of Engineers January 27, 1887.

Under the specifications either of two designs of mattresses could be used, at the option of the contractor. The first design calls for a mattress formed of logs overlaid with brush. In the second design the mattress consists of a grillage of poles covered with brush and topped by a second grillage of poles. These designs are essentially the same as have been used in the work since its commencement, as described on page 1246 of Report of the Chief of Engineers, 1885.

Under the specifications the best quality of the stone so abundant in the western half of the peninsula of Florida can be used. The stone must be as hard as hard-burned brick, and average specimens must weigh not less than 145 pounds to the cubic foot. As this stone is much lighter than the gneiss heretofore used, it is purchased by weight, determined by the displacement of lighters, the weight of the water being assumed as 62.5 pounds per cubic foot.

Operations under the contract began March 15, and have been prosecuted vigorously throughout the year. Fourteen thousand eight hundred and seventy-five square yards of mattresses and 10,116 tons of stone have been placed on the North Jetty, and 1,595 square yards of mattresses and 1,149 tons of stone were placed in the old sailing gap in the South Jetty. The mattresss have been all of the first design.

The stone has been mainly the Florida stone, brought from the neighborhood of Archer and Arredondo by rail to Jacksonville and there shipped on scows to the jetties. It is very compact, hard, and angular, and of suitably random sizes. The draught of the stone scows is obtained accurately, even in a sea-way, by the following method: A well passes through each end of each scow, inside the rake and as close to the keel as possible. To obtain the draught a tube four inches in diameter, pierced with a small hole at the bottom and containing a float carrying a rod which projects beyond the top of the tube, is thrust into the well and clamped with its top even with the deck of the scow. The height of water in the well is determined from the readings on the rod. This apparatus has given entire satisfaction. The average weight of the stone per cubic yard as thus determined is 2,200 pounds.

The mattress used is not satisfactory. It is too stiff to follow the irregularities of the bottom closely. When less than 100 feet wide the water finds little difficulty in passing under it and, by eroding the sand, in lowering it, in one instance as much as 20 feet. This action has not been observed in any of the broad mattresses laid under the present contract. When laid in shallow water, unless closely covered with rock, the brush entirely disappears under the wearing action of the water and the ravages of the teredo. Few traces can be seen of the brush on the matresses laid in 1885 near the low-water level. The pole binders have also disappeared in many places where the logs are intact and apparently uninjured.

In the work of the present year the foundation mattresses are 120 feet wide. They are laid so that for any two contiguous mattresses the axis of the jetty is 45 and 55 feet, respectively, from the ends outside, and 75 and 85 feet, respectively, from the ends inside the jetty lines. This arrangement throws a great width of apron inside the jetty line, where there is the greatest danger of scour from parallel currents, and makes the edge of the apron a broken line. Where there is a depth of more than 12 feet of water over the foundation mattresses a second course is laid. The mattresses of this course are regulated in width for a jetty with the following cross-section: Superstructure of stone, with top 12 feet wide and 5 feet above mean low-water level, resting on a mattress 20 feet wider than the base. Lower courses of mattresses are 8 feet wider than the course immediately above. The foundation mattress has, in all cases, the full width of 120 feet. All mattresses above the foundation-course are laid symmetrically with respect to the axis of the jetty.

When operations under the present contract began, the greater part of the water escaping across the lines of the jetties passed through the channel across the end of the north jetty. This channel was 20 feet deep at this point, and the last mattress of the jetty, which, when laid in September, 1885, was covered by only 18 inches of water, had been lowered until its east and west ends were 12 feet and 5 feet below mean low water, respectively. This scour extended for 170 feet back from the end of the jetty as then built.

The first work was done at this point. The foundation course was extended, and in the deep water of this channel a second course of mattresses was laid 227 feet long and 75 feet wide. Beginning at this point the jetty has been extended 937 feet and built up to an average height of 5 feet below mean low water. The sand-bank was scoured out ahead of the jetty as it advanced and the last mattresses were laid in 7 feet of water, where, when work began, a bank bare at low water stood. On account of the probability that any mattress laid in very shallow water will be underscoured and caused to sink when a deep channel is formed near it, it is considered most advantageous to secure a moderate depth of water in advance of the jetty before placing the foundation mattresses. The scour in advance of the jetty is therefore beneficial, when not permitted to go too far, and the location where work is to be done is in some degree determined by it; the general design for work under this appropriation being to extend the jetties as far as possible, with the foundation mattresses in about 10 feet of water, and to build the riprap superstructure to the height of mean low water from the shore out, with a top width of 12 feet, and the sides at the slope taken by the stone under the action of the water. The distance of the superstructure to the rear of the foundation during construction is regulated by the scour in advance, as mentioned above. The work will be done in either jetty as necessity requires.

In accordance with this plan the south jetty sailing gap was closed to the level of 12 feet below mean low water by two courses of mattresses laid across its deepest part, and properly ballasted.

Work under the appropriation up to June 30 has then comprised the construction of 364 feet of pile and mattress dike, shore extension, north jetty; the extension of the north jetty 937 feet by a foundation course of mattresses 120 feet wide, properly ballasted; the extension of the jetty superstructure by a second course of mattresses 227 feet long and 75 feet wide and by stone; and the partial closing of the sailing gap through the south jetty by two courses of mattresses and the necessary amount of stone. In all, 11,265 tons (2,000 pounds) of stone (10,241 cubic yards) and 16,470 square yards of mattresses were used.

The line of direction for the prolongation of the north jetty was definitely fixed as shown in the accompanying chart. The width between the sea ends of the completed jetties will be 1,600 feet.

Mr. D. B. Dunn, assistant engineer, is in local charge of this work, assisted by Capt. W. T. McNelty, superintendent, and Messrs. Otto Bie and J. S. Houston, inspectors. To all of these gentlemen I am indebted for faithful work.

CONDITION OF THE WORK JUNE 30, 1887, AND EFFECTS ON THE BAR.

The total length of the south jetty is 6,715 feet. For a length of 2,650 feet from the shore its top is practically at the level of mean low water. There has been no change in this portion of the jetty during the past year. The entire surface where exposed is covered by a thick growth of shell-fish, which binds the parts firmly together and makes the jetty tight. Beyond this point, excepting where the new work was placed in the deep portion of the sailing gap, the entire jetty has been lowered from 1 to 2 feet. It is probable that this lowering is due to causes other than scour across the jetty, inasmuch as sand is found on the jetty in many places and is at the level of its top on the south side.

The north jetty has a total length of 5,619 feet, with its top at the level of mean low water for about 3,000 feet. The remaining length is built to a height about 6 feet below this plane. Where the mattresses are exposed the logs show few traces of the action of the teredo; the binders are frequently missing and the brush has almost entirely disappeared. The stone is well covered with shell-fish.

The changes within the shore 6-foot curve have been unimportant, though a slight building out of the shore is everywhere apparent.

The areas inclosed by the 6-foot curves of the bar are about the same as last year, but the water within the curves is deeper and the channels separating them are deeper and more pronounced. Between the jetties the shore 12-foot curve has advanced to the north jetty on the north and to a point 800 feet beyond the end of the south jetty on the south, where it is only 900 feet from the sea 12-foot curve. At this point the outer 24 and 30-foot curves are, if anything, a little nearer shore than in June, 1886. The minimum channel depth on the bar is now 9.6 feet, and this depth is increasing. The jetty channel has been used exclusively since March, 1886.

The changes in direction of the contours on the north side of the channel at the mouth of the river under the influence of the north jetty, noted in the last annual report, have continued. These changes have produced a slight shoaling in the mid-river just outside the shore-line. It is probable that as the north jetty is extended and built up the main channel will form just south of it. It is possible that while this change is taking place, and before this north channel has been cut completely through the remains of Ward's Bank, this point may be shoaler than the bar itself. This condition would only be temporary and would cause little inconvenience.

With the remainder of the appropriation available it is proposed to continue the work under the present contract. In addition, a small sum will be expended in testing the cost and utility for the superstructure of the work, of concrete made with the sand and shell at hand. Tests will also be made to determine the value of oyster-shells as a hearting for the riprap, so as to utilize if possible the large deposits of the shell mounds near the work.

SHOALS BETWEEN JACKSONVILLE AND THE BAR.

The latest charts show four points below Jacksonville where there is not a continuous channel with a least mean low-water depth of 15 feet, viz, at Dame's Point, below the mouth of San Carlos Creek, opposite Saint John's Bluff, and below Marsh Island. I would recommend that a special appropriation be made for the examination of these points in order that a project for their improvement may be prepared, or else that a portion of the appropriation for the improvement of the river be made available for this purpose. The estimated cost of this examination is $1,500.

NECESSITY FOR AN EARLY APPROPRIATION.

I would again invite attention to the increase of the cost of this work due to the numerous interruptions and delays in its construction, caused by the exhaustion of the funds available.

From the date of the first appropriation, June 14, 1880, to June 30, 1887, the records show that work has been carried on during forty-nine months and has been idle during thirty months. There have been five appropriations and five contracts. The average time which has elapsed between the date of each appropriation and the date on which work began under the corresponding contract is five months. This is the time necessarily taken, under the law, for submitting the project for the expenditure of the appropriation, for advertising for proposals, for preparing the contract, and for gathering the plant. In order to permit the work to be carried on continuously, the money for a new contract must be available about that length of time before the previous appropriation has been exhausted.

The sources of loss to the United States on this work arising from the irregularity in the prosecution of the work are as follows:

(1) The deterioration of the unfinished work.

(2) The additional work needed to repair damages caused durin time when no funds are available, by the partly controlled curr cutting around the ends of the jetties and pouring over the low tions, causing scour and settlement. The cost of 600 feet of shore tension of the North Jetty may be placed under this head.

(3) The uneconomical methods rendered necessary. Under the p ent system, since he can not know when his plant can be used ag the contractor must arrange his prices so that the profits under e contract will cover the value of the plant required, in addition to customary allowances made for interest on money invested, for r run, and for time consumed. Should the work be done by the Un States by hired labor, during the intervals of idleness the plant mus cared for and its deterioration paid for, as under the law it can no sold for the benefit of the appropriation.

The straight and steadily deepening channel already formed i guarantee of the final success of the work. In the interests of econo it should be vigorously pushed to completion.

The commercial interests most directly affected by the improvem are described in the accompanying letter from Mr. James M. Fair secretary of the Board of Trade of Jacksonville, to which I would pectfully invite attention:

This improvement is located in the collection district of Saint John's. Jack ville is the nearest port of entry. Nearest light-house is Saint John's River li Nearest fort is Fort Clinch.

The following maps accompany this report:

Mouth of river, 1887; scale $\frac{1}{6000}$; two sheets, comparative maps, mouth of ri 1883, 1885, 1886, 1887; one sheet profiles of jetties, 1885, 1886, 1887.

Money statement.

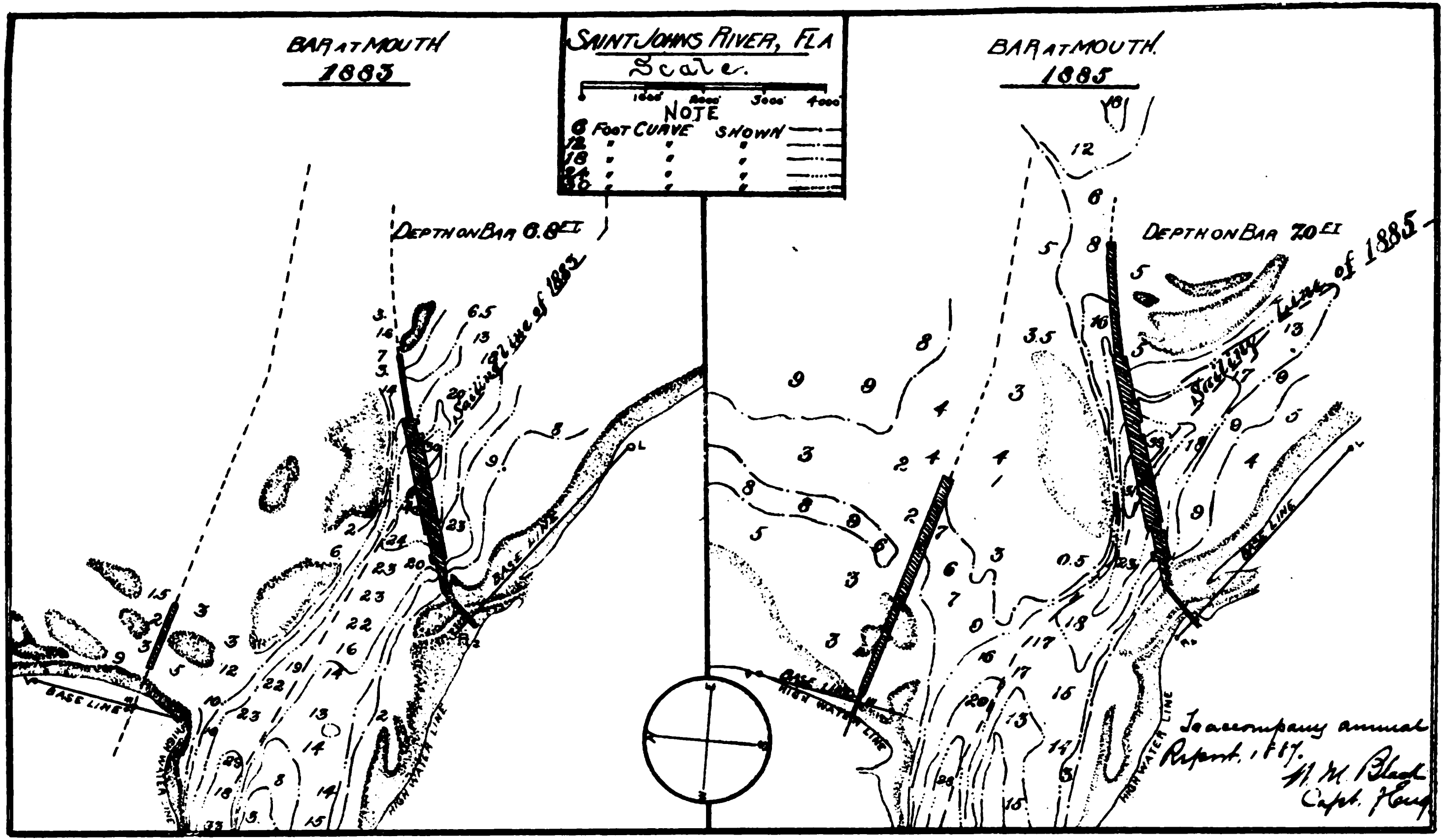
July 1, 1886, amount available		$1,93
Amount appropriated by act approved August 5, 1886		150,00
		151,93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	27,985.89	
July 1, 1887, outstanding liabilities	12,206.62	
		40,19
July 1, 1887, amount available		111,74
Amount (estimated) required for completion of existing project		743,15
Amount that can be profitably expended in fiscal year ending June 30, 1889		300,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for building shore extension, North Jetty, Saint John's River; o November 9, 1886.

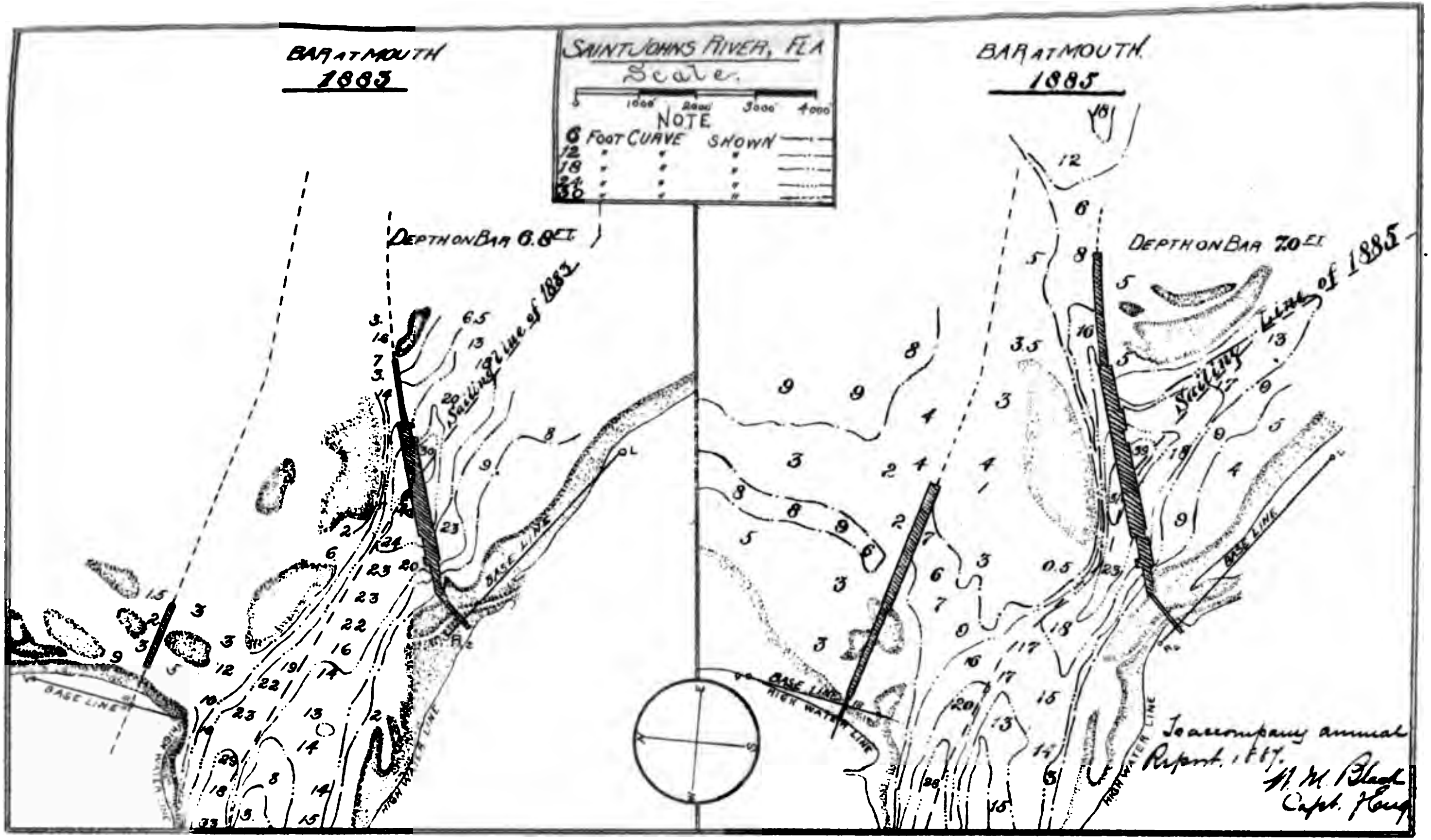
No.	Names of bidders.	Price per linear foot.	Tota
1	Samuel R. Cumming	$21.98	$7,9
2	Marcus Conant	14.00	5,0
3	J. A. Bryan*	7.22	2,5

*Lowest bidder.



To accompany annual Report, 1887.
W. M. Black
Capt. Eng.

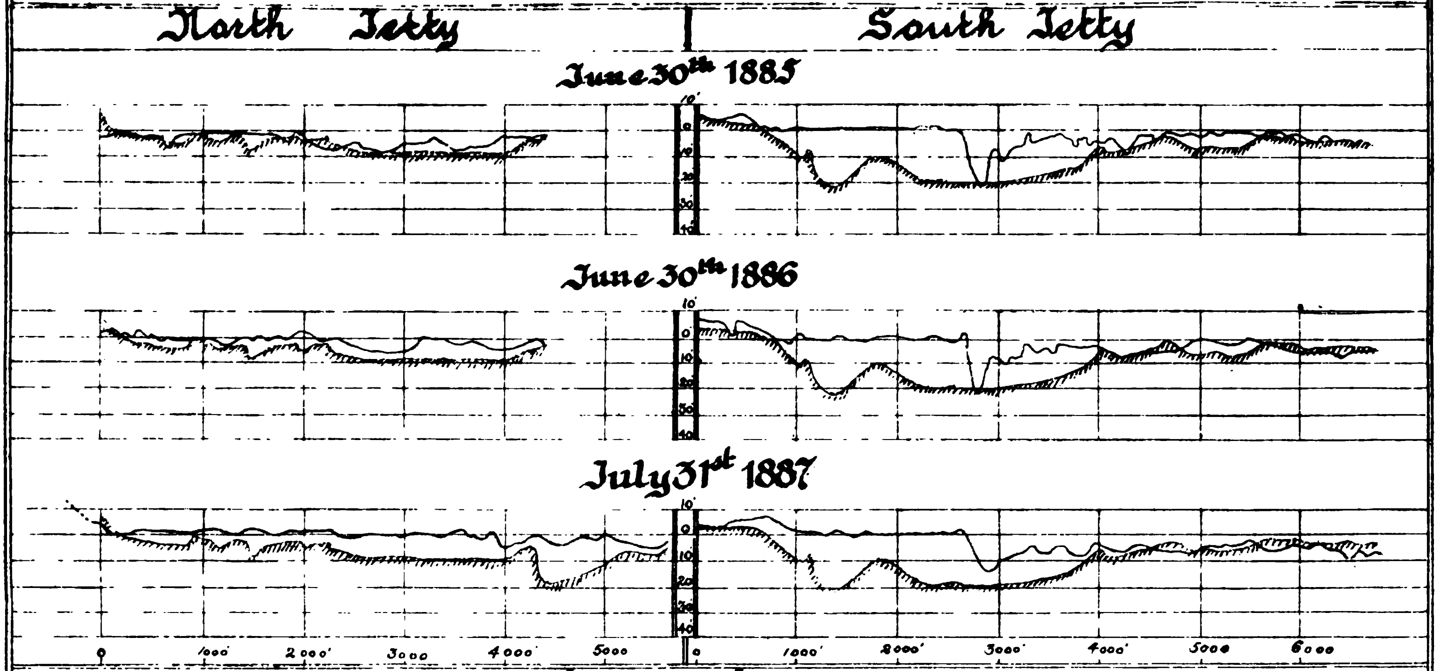
2



To accompany annual Report, 1887.
W. M. Black
Capt. Eng.

2

Comparative Profiles of the Jetties at the Mouth of the Saint Johns River, Fla.



To accompany Annual Report 1887.
W. H. Black.
Capt. & Eng.

Note: Bottom when Mats were laid is shown thus: ⁓⁓⁓
Profile along Axis of Jetty " " " ～～～
0 = Mean Low Water.

Abstract of proposals for construction of jetties, Saint John's River, Florida; opened December 11, 1886.

No.	Names of bidders.	Mattresses. Price per square yard.	Stone. Price per ton (2,000 pounds).
1	John W. Gaynor	$0.78½	$3.60
2	R. G. Ross	.54	2.70
3	Rittenhouse Moore*	.45	2.45
4	James A. Bryan	.49	2.87½

* Lowest bidder.

LETTER OF THE SECRETARY OF THE BOARD OF TRADE OF JACKSONVILLE, FLORIDA.

ROOMS OF THE JACKSONVILLE BOARD OF TRADE,
Jacksonville, Fla., July 20, 1887.

DEAR SIR: In compliance with your request addressed to the President of this Board, I beg, most respectfully, to hand you the following statistics, which have been carefully compiled by me from information obtained for the purpose from the merchants and shippers of this city.

I am, very truly,

JAMES M. FAIRLIE,
Secretary.

To W. M. BLACK,
Captain of Engineers, U. S. A.

COMMERCIAL STATISTICS FURNISHED BY MR. JAMES M. FAIRLIE SECRETARY JACKSONVILLE BOARD OF TRADE.

The population of Jacksonville, including suburbs, is upwards of 30,000, the increase being nearly 100 per cent. in the past five years.

There are nearly 6,000 buildings in the city, 975 of which are used for mercantile pursuits.

By a recent act of the State legislature, the city boundaries have been extended. The city of Jacksonville now embraces within its territorial limits all of the principal suburban towns and villages. It has a river frontage of nearly 6 miles on one side of the river.

It is the railroad center for the State of Florida, and the link which connects the State with the North and West.

There are 2,265 miles of railroad in operation in the State of Florida, all of which have direct connection with the city of Jacksonville. Fully half of the lumber, naval stores, oranges, fruits, vegetables, and other domestic products shipped from the interior of the State, passes through Jacksonville.

The Florida Fruit Exchange, located in Jacksonville, handles the bulk of the fruit and truck. A cotton warehouse is now in course of construction, with the view of making Jacksonville the cotton market of the State.

There are two steamship lines and a large number of schooner lines connecting Jacksonville with the large business centers of the North. One hundred and thirteen coastwise and 22 foreign sailing vessels, 89 coastwise and 11 foreign steamers, with a combined tonnage of 146,708 tons, arrived at the port of Jacksonville during the year ending June 30, 1887—an increase of 22,466 tons over the previous year.

One hundred and eighty-eight coastwise and 26 foreign sailing vessels, and 101 coastwise and 12 foreign steamers, with a combined tonnage of 151,101 tons, cleared from the port of Jacksonville during the year ending June 30, 1887—an increase of 34,057 to tons over the previous year.

The imports and exports of the port of Jacksonville have been less during the past year than during the year immediately preceding, but much greater than in former years. The establishment of a permanent direct steam-ship line between Jacksonville and the Bahama and West India Islands will add materially to this branch of commerce.

Almost the entire trade of Florida is dependent on water routes. Fully two-thirds of the entire trade of the State is tributary to Jacksonville; a large proportion of it, however, comes and goes by way of Savannah, Charleston, and Fernaudinana, the reason being that as there is deeper water on the bars at these places heavy draught steam and sailing vessels can make more rapid and cheaper landings than at present by way of the St. John's River. It is acknowledged, however, by shippers and ship-masters alike, that if there were 18 feet of water permanently on the St. John's Bar the greater bulk, if not the whole, of this trade would come direct by water to Jacksonville, and would save to the merchants of that city as well as the business men of the interior towns of Florida not less than $500,000 per annum. This amount is being paid at present by these parties, partly on account of increased freight rates owing to shipments being sent partly by rail; also on account of increased insurance rates, loss by delays and damage to vessel and cargoes, owing to the present unsatisfactory condition of the St. John's Bar and portions of the St. John's Channel.

This general average of the loss to the commerce of the city of Jacksonville is indorsed by Capt. Thomas S. Eells, the underwriter's agent at Jacksonville.

The following table gives a partial statement of the amount of business done in the city of Jacksonville during the year ending June 30, 1887:

Class of goods.	Quantity sold.	Hands employed.	Salaries paid.	Total value of goods sold.
Corn.....bushels..	606,200	100	$97,120.00	$2,380,222.70
Oats.....do....	847,954			
Wheat.....do....	34,674			
Hay.....tons..	11,702			
Bran and feed.....do....	5,088			
Flour.....barrels..	24,480			
Grits and meal.....do....	38,560			
Cotton-seed meal.....tons..	6,032			
Groceries and provisions	.....	435	387,534.00	3,765,481.00
Lumber and naval stores	.....	900	750,000.00	4,824,000.00
Dry-goods, boots, and shoes	.....	254	223,000.00	1,561,000.00
Hardware and building material	.....	521	542,500.00	3,268,500.00
Furniture	.....	73	37,250.00	287,000.00
Earthenware	.....	61	26,050.00	125,000.00
Sewing-machines and musical instruments	.....	60	28,500.00	128,500.00
Printing, books, and stationery	.....	219	213,230.00	2,558,760.00
Jewelry and works of art	.....	115	10,500.00	126,000.00
Drugs and chemicals	.....	119	22,637.00	158,659.00
Fruits and vegetables	.....	143	14,300.00	100,100.00
Confections and sundries	.....	125	19,000.00	133,000.00
Wines and liquors	.....	250	223,500.00	5,175,000.00
Cigars	.....	550	350,000.00	1,750,000.00

In addition to these thus enumerated there are the railroads, shipping companies, machine and boiler shops, ship building and repairing yards, iron works and foundries, carriage and harness shops, brick yards, stone and terra-cotta works, fertilizer, palmetto goods, and brush manufactories, etc., and others of varied character, which would make the above estimate more than double.

O 2.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

Operations for improving Volusia Bar, Florida, have been carried on at intervals since December, 1880. Four appropriations have thus far been made by Congress for its improvement previous to the current fiscal year, aggregating $17,500.

Volusia Bar is located at the south end or head of Lake George, about 162 miles by river from the mouth of St. John's River, at the point where the waters of the river flow into the lake.

Twelve steamboats pass this point daily, having a total tonnage of about 5,130 tons.

An examination of Volusia Bar with a view to its improvement was made in March, 1879. A report thereon, dated July 16, 1879, with plan of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879.

This was modified as reported in the Annual Reports of the Chief of Engineers for 1882 and 1883, Appendix J 11 and L 14, respectively.

PROJECT OF IMPROVEMENT.

This consists of the narrowing of the channel by two converging brush and stone jetties, starting from the shore and extending to the 6-foot curve in the lake, and with such width between the ends as will maintain a channel-depth of 6 feet at low water, where before improvement the depth was 3½ to 4½ feet. The channel is to be further defined and guarded by rows of fender-piles. Dredging is to be resorted to if necessary to obtain the required depth.

The estimated cost of the revised project is $25,000.

It is estimated that about 12,000 cubic yards of material should be removed by dredging.

OPERATIONS TO JUNE 30, 1886.

The West Jetty, built on a straight line bearing north 25 degrees west, has reached a length of 2,206 feet from shore. For the greater part it is formed of a single course of pole and brush mattresses, from 6 to 12 feet wide, loaded with broken stone. A second course of 6-foot mattresses covers 159 linear feet of the outer portion of the jetty.

The shore end of the East Jetty is about 2,400 feet east of the West Jetty. It is built on lines by which it gradually converges towards the latter work in approaching the bar. Its aggregate length is at present 3,459 feet. From the shore it extends 1,836 linear feet on a range bearing north 76 degrees west; the next length of 1,100 feet bears north 63 degrees west, and the remainder, which is located upon the bar, runs about parallel to the opposite part of the West Jetty and 240 feet from it. It generally consists of a single course of mattresses, from 6 to 12 feet wide, covered with riprap stone, except for 247 feet length at the bar, where a second course was put on.

One hundred and fifty fender-piles were driven on the bar, nearly all in clusters of three and four, in two rows 75 feet apart. Each row extends over a length exceeding 800 feet and runs about parallel to the West Jetty. The row nearest to that work is 100 feet from it. At the beginning of the fiscal year, July 1, 1884, all of these piles had been broken or knocked down. In this condition they formed a serious obstruction to navigation.

In 1885 the broken piles were removed. New piles were driven in clusters and securely fastened with chains. The width between rows was increased to 100 feet and the piles were increased in size. Stone was placed on low spots on the East Jetty.

The appropriation having been nearly exhausted no operations were carried on during the year ending June 30, 1886.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

In act approved August 5, 1886, $7,500 were appropriated for this work. With this appropriation it was decided to raise the jetties to low-water level by brush fascines loaded with stone, and to repair and strengthen the lines of guide piles, in accordance with the desire of the steamboat men, who found great difficulty in following the jetty channel during high winds without their aid.

On account of the frequent loss of piles in previous years it was decided to greatly strengthen the system by placing single piles between the clusters, at 10-foot intervals, and by binding the whole strongly together by two lines of waling strips.

On November 9, 1886, proposals were opened for continuing the improvement in this manner.

A contract for doing this work was entered into with Mr. James A. Bryan, the lowest bidder, which was approved by the Chief of Engineers November 29, 1886.

Work under the contract was commenced January 24 and completed May 16, 1887; 361.41 cubic yards of fascines and 858 cubic yards of stone were placed in the East and West jetties, bringing them up to the level of mean low water for distances of 2,930 and 1,940 feet from shore, respectively.

It was considered best to leave the ends low, inasmuch as a very heavy current was produced by this work, and because on account of the very slight depth in the lake there was some danger of forming the bar outside of the jetties; 176 piles were driven in the guide rows. The piles of the clusters were firmly fastened together with chains. The piles were driven 15 feet into the sand. The tops of the old piles were coated with coal tar and all were capped with tin for protection against the weather. Two lines of 8-inch by 10-inch waling strips were placed on each row and firmly bolted to the piles. The scarfs in these strips were also coated with tar.

An examination made July 7 showed that the least depth in the channel on the bar is 5 feet. The general depth varies from 5 feet to 5.9 feet. The current is very swift, and a further contraction of the stream would be detrimental to navigation.

The lake is very shallow. The 6-foot, 7-foot, and 8-foot curves are now 420 feet, 780 feet, and 1,440 feet, respectively, beyond the end of the jetties. At a distance of 3,464 feet beyond the jetties the maximum depth found was 9.6 feet.

The draught of the regular lines of steamers navigating the St. John's River varies from 3 to 5.5 feet, and the depth now on Volusia Bar is greater than on bars above, between Lakes George and Monroe.

Under these circumstances it is not advisable to attempt to deepen the channel in the bar further at present.

No appropriation is asked for the coming year. The amount on hand will be used in maintaining the work, which can be done with an annual expenditure of $500.

Commercial statistics were asked for but could not be obtained.

This work is in the collection district of Saint John's; Jacksonville is the nearest port of entry. Nearest light-house is Volusia Bar light. Nearest fort is Fort Marion. Amount of revenue collected in 1887, $1,759.

Money statement.

July 1, 1886, amount available		$147.74
Amount appropriated by act approved August 5, 1886		7,500.00
		7,647.74
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,897.30	
July 1, 1887, outstanding liabilities	37.87	
		6,935.17
July 1, 1887, amount available		712.57
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		500.00

Abstract of proposals for improving Volusia Bar, Fla., opened November 9, 1886, by First Lieut. W. M. Black, Corps of Engineers.

Number of proposals.	Name of bidder.	Fascines.			Stone or concrete.			Piles.			Waling strips.		
		Estimated number of cubic yards required.	Price per cubic yard.	Total.	Estimated number of cubic yards required.	Price per cubic yard.	Total.	Estimated number of piles to be driven.	Price per pile in place.	Total.	Estimated number of feet, B. M.	Price per 1,000 feet, B. M.	Total.
1	R. G. Ross	1,055	$2.00	$2,110.00	527.3	$4.50	$2,372.85	153	$5.00	$745.00	17,500	$30.00	$525.00
2	Geo. A. DeCottes	1,055	2.50	2,637.50	527.3	5.50	2,900.15	153	5.50	841.50	17,500	32.50	568.75
3	S. R. Cummings	1,055	.72½	764.88	527.3	5.30	2,794.69	153	5.92½	906.53	17,500	20.00	350.00
4	J. A. Bryan	1,055	.75	791.25	527.3	4.75	2,594.68	153	4.50	688.50	17,500	20.00	350.00

Number of proposals.	Name of bidder.	Chain.			Sawing off all piles not redriven.			Rechaining old piles not redriven.			Total.
		Estimated number of pounds of chain required.	Price per pound in place.	Total.	Estimated number of old piles to be sawed off.	Price per pile.	Total.	Estimated number of pounds of chain.	Price per pound for rechaining.	Total.	
1	R. G. Ross	6,000	$0.10	$600.00	115	$1.00	$115.00	4,500	$0.10	$450.00	$6,937.88
2	Geo. A. DeCottes	6,000	.08	480.00	115	.25	28.75	(*)	3.00	111.00	7,567.65
3	S. R. Cummings	6,000	.08	480.00	115	(†)	96.00	......	5.50	632.50	6,024.60
4	J. A. Bryan‡	6,000	.10	600.00	115	.25	28.75	4,500	.10	450.00	5,413.80

*37 clusters.
†Also bids on bolts separate, 1,600 pounds, at 6 cents per pound.
‡Lowest bidder.

Contract awarded J. A. Bryan, with the approval of the Chief of Engineers.

O 3.

IMPROVEMENT OF THE UPPER ST. JOHN'S RIVER, FLORIDA.

By the river and harbor act approved July 5, 1884, the sum of $5,000 was appropriated for improving the Upper St. John's River, Florida. This is the first appropriation ever made by Congress for this work.

The part of the St. John's River referred to in the act is presumed to be that portion extending from Lake Monroe to the head of Lake George, a distance by river of about 45 miles. An examination of this section was made in the early part of the year 1879, report of which, dated July 16, 1879, with a project of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879. It was stated in that report that the stream, although very crooked, is of ample depth for any class of vessels adapted to the navigation of the Upper St. John's River, and that the only gain to be secured by cut-offs is strictly in distance. It was suggested to confine the work of improvement to cutting off the four most prominent bends, located as follows:

(1) A bend three-fourths of a mile above Old Town, 25 miles below Lake Monroe.

(2) Two bends about 2 miles below Manuel's Landing, 7½ miles below Lake Monroe.

(3) A bend at Manuel's Landing, 5½ miles below Lake Monroe. The results of a later examination of the same section of the river, made in conformity to a provision in the river and harbor act passed August 2, 1882, did not differ from the conclusions previously reached.

Pursuant to instructions from the Department, another report was submitted October 5, 1883, with revised plans and estimates.

The width of the river at the bends named varies from 130 to 150 feet, and in the reaches connecting them from 150 to 200 feet. The banks and adjoining ground average 4 feet above water-surface at low-river stage. The plan of improvement contemplates cut-offs 100 feet wide at the bottom, side slopes 1 on 1, and a low-river depth in the cuts of 6 feet. This depth was adopted as being the maximum low-river depth at the shoalest places between Little Lake George, 20 miles below the head of Lake George, and Lake Monroe.

Two estimates were submitted, one for straight cut-offs with quite easy curves so as to offer no obstruction to navigation. The work would principally consist of dredging, but a few light closure dams would have to be built and some grubbing done. The estimated cost of this improvement is $43,000 for straight cut-offs and $38,800 for curved cut-offs. The latter system has been adopted.

The appropriation available being small, it was proposed to begin operations by opening the shortest cut—that at Old Town. Proposals for this work were invited to be opened October 24, 1884. No bids were received.

Under these circumstances, with the approval of the Chief of Engineers, it was decided to await further appropriations before beginning the work.

This part of the river is passed over by steam-boats about twelve times per day.

The balance available and the appropriation asked for are to be used in accordance with the approved project.

This work is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Nearest light-house is Volusia-Bar Light. Nearest fort is Fort Marion. Amount of dues collected in fiscal year, $1,759.

Money statement.

July 1, 1886, amount available	$4,975.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3.44
July 1, 1887, amount available	4,971.72
Amount (estimated) required for completion of existing project	33.800.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

O 4.

SURVEY OF ENTRANCE TO HARBOR OF KEY WEST, FLORIDA, AND PROJECT FOR ITS IMPROVEMENT.

The Florida Keys consist of a chain of rock and sand islands extending southwesterly from Cape Florida for nearly 200 miles. They are connected by extensive sand-flats, underlaid by the rock, a soft oolitic limestone, from which the sand is almost entirely formed.

This chain is a barrier for all shipping from the Atlantic to the Gulf (eastern and middle) ports; and the straits between it and the West India Islands form a passage justly dreaded by mariners. This barrier is crossed by four navigable channels, one between the Dry Tortugas, at the western extremity of the chain, and Rebecca Shoals; one east of Rebecca Shoals; the third (the Boca Grande Channel) 28 miles farther east; and the fourth (the northwest channel of Key West Harbor) immediately west of Key West, 65 miles east from the Dry Tortugas. It is this easterly position, combined with the good harbor of Key West at its extremity, which gives this channel its importance. It is used by vessels en route between the Atlantic Ocean and Gulf ports which do not draw more than 10½ feet of water, the depth available on the bar which now obstructs its northern end. An average daily tonnage of (estimated) 2,500 tons passes through it. In rough weather the available depth is still more reduced, and vessels of more than 8 feet draught are compelled to pass through one of the channels near Tortugas, the Boca Grande Channel being also impassable at such times.

The necessity for the improvement of the channel over this bar was first brought to the notice of Congress in 1868. An examination of the bar was ordered. This was made by Lieut. (now Maj.) W. R. Livermore, Corps of Engineers, under the direction of Col. J. H. Simpson, Corps of Engineers. A project was submitted for opening a dredged channel across the bar, 300 feet wide, 18 feet deep at mean low water, and 9,000 feet long, at an estimated cost of $217,272. Nothing more seems to have been done at that time.

In 1881 another examination of the harbor was ordered by Congress. This was made by Mr. Thomas L. Harrison, assistant engineer, under the direction of Capt. (now Maj.) A. N. Damrell, Corps of Engineers, as reported on page 1314, Report of the Chief of Engineers, 1882. Major Damrell submitted a project for dredging a cut 300 feet wide and 17 feet deep at mean low water, at an estimated cost of $140,000. In 1882 Congress appropriated $25,000 for work under this project. With this, a cut 60 feet wide and 15 feet deep at mean low water was made across the bar in 1883. In his report, submitted August 12, 1884, Major Damrell states: "Unofficial reports as to the filling up of the dredged channel confirm the opinion expressed in my last annual report, namely, that the improvement would not be permanent. No appropriation is asked for, at least until a further examination can be made."

In his report submitted July 20, 1885, the officer then in charge, Capt. William T. Rossell, Corps of Engineers, confirms the report as to the filling up of the dredged channel, and asks that "an appropriation of $3,500 be made for an examination before more work is attempted."

In August, 1886, Congress appropriated $2,500 "for examination and survey of the entrance to harbor at Key West, Fla." This survey was made in December, 1886, and January and February, 1887, by Mr. J. W. Sackett, assistant engineer, to whom, with his party, my acknowledgments are due for faithful and efficient work. No help could be obtained from the previous surveys, as the bench-marks left by them had disappeared and the work had to be done *de novo*. This, with the expected interruptions due to stormy weather and the exposed site, made it impossible with the reduced appropriation ($1,000 less than the estimate) to obtain all of the data which are needed for a full discussion of the subject. Enough has been obtained to base a project upon, though the full effects of the improvement recommended for this exposed site can not be foretold.

DESCRIPTION.

The Northwest Channel is bounded and defined by the extensive sand-flats of the reef. These are in this vicinity covered by from 2 to 4 feet of water excepting towards the north side of the reef, where the water deepens to from 5 to 10 feet. The general outlines of the channel, wide and deep at the southern entrance, and gradually narrowing and shoaling until it is almost lost on the flats of the north side of the reef, would proclaim it to be a channel formed and maintained essentially by the flood currents from the Atlantic Ocean. It starts between buoys No. 9 and No. 11, due west from Fort Taylor, Key West, and runs almost straight in a northwesterly direction for a distance of 6 miles, with a general channel width of nearly one-half mile and a depth of from 19½ to 21½ feet. There it shoals to from 15 to 17 feet, but continues its course for 1 mile farther, when it divides. What is apparently the main channel turns sharply toward the southwest, and continues in that direction, with a width of about one-fourth mile and a depth of from 11 to 15 feet, for about 2 miles more, when it spreads, and is lost on a flat covered by not more than 7 feet of water.

The other branch turns sharply to north by east, and passes through devious, bar-obstructed channels to the deep water of the Gulf, a distance of about three-fourths of a mile. This is the real ship-channel. It has a maximum available depth of 11 feet, and is the "entrance" whose improvement is desired.

CHARACTER OF BAR.

The oolitic coral rock of which the reef is composed is found at various depths in the vicinity of this bar. Near the light-house and beacon it lies at a depth of from 8 to 15 feet, and has its surface swept clean of sand by the currents. On the bar itself the rock could not be found at a depth of 18 feet. The exhaustion of the appropriation prevented more extensive boring operations.

The sand overlying the rock is almost entirely formed from it. Tested with nitric acid, there was no visible solid residuum. A cubic foot dry, settled by shaking, weighed 80 pounds. Saturated with water it weighed 111 pounds, showing the volume of voids to be about 50 per cent. of the whole. One-half-grain weight of sand contained 4 pieces of shell 0''.03 to 0''.06 in diameter; 6 rounded calcareous particles 0''.03 to 0''.08 in diameter; and 1,199 subangular pieces with an average diameter 0''.005. Allowed to fall through water, the final velocity attained was 1''.6 per second for the larger and 0''.52 per second for the finer grains. Hence vertical currents of that velocity would keep this sand constantly in suspension. During storms the water over the entire bar and flats assumes a milky appearance from the sand stirred up by the wave action.

WINDS AND WAVES.

From the observations of the U. S. Signal Service in Key West, taken three times daily from 1871 to 1886 inclusive, Plate XIX has been prepared, to show the relative frequency of winds from the different quarters. Taking the number of days on which west winds prevailed as unity, 1.1 would represent the number of calm days. The largest number, 9.2, represents the number of days of east winds. "The prevailing winds during each month are as follows: January, northeast; February, east-northeast; March, northeast to southeast; April to September, east; and October to December, northeast. In four of the sixteen years considered, north winds prevailed in January and February. The northerly winds have the greatest average velocity."

"In all the observations taken of the direction of the waves, in calm weather and in storms, they invariably came from some point between the north and northwest. For instance, the record of observations at Station Beacon January 11, at 10 a. m., shows that a stiff breeze was blowing from north 22° east, with the current setting north, while the waves, 3 feet in height (6 from crest to hollow), with a period of three seconds, were coming from north 20° west." (Report of Assistant Engineer Sackett.)

The ship captains report the maximum height of waves in the Gulf, near the Keys, as about 10 feet from hollow to crest, and that waves never break in 18 feet of water.

TIDES AND TIDAL CURRENTS.

There are two tides daily in the northwest channel. The reports of the U. S. Coast Survey show a range of 3.5 feet for spring tides and of 1.9 feet for neap tides. Continuous observations taken at the northwest light-house for one month during the survey show a mean range of tide of 2.63 feet; the minimum was .73 feet and the maximum was 4.8 feet in any one day. The maximum was during a calm, and the minimum during a high wind from the north. The maximum variation in the height of two successive high waters was .88 feet, and of two successive low waters 1.75 feet. In both instances there was little or no wind. Mr. Sackett reports that in general the height of the tide was but little influenced by the wind, though irregularities in the times of high and low water were probably produced by it.

The time of high water at the northwest light-house is later than at Fort Taylor, Key West, by a mean of 2 hours and 13 minutes and of low water by 1 hour and 39 minutes. The time of high and low water at the bell buoy was not observed. At the light-house the mean interval for 73 tides from high water slack to low water slack is 6 hours and 15 minutes, and from low water slack to high water slack, 6 hours and 21 minutes.

The total computed flow through the northwest channel near the channel buoy, 2 miles southeast from the light-house, during one ebb tide, lasting 6 hours and 15 minutes, was 3,363,647,439 cubic feet; during one flood tide, lasting 7 hours and 15 minutes, 5,424,814,427, giving a mean velocity of 1.09 feet per second for the ebb and 1.49 feet per second for the flood.

DIRECTION OF CURRENTS.

The currents in the channel proper follow the general direction of the channel, flowing northwest during floods and southeast during ebbs. Their velocities during one tide are shown on Plate XVII. The relative directions and velocities of the currents near buoy No. 3 (on the bar) and at the bell buoy (off the bar) are plotted on Plate XV. An examination of this plate shows "that at the stations on the bar and at the bell buoy, which are not in a confined channel, the direction of the current varies during the ebb and flow through the entire arc of the horizon." This plate shows that the direction of the currents at the mouth of the channel are modified by the ebb and flow along the northern face of the reef. The general trend of the north face of the reef and of the northwest channel are also shown on the plates. The flood currents through the northwest channel are stronger than the ebb, as might be expected from considerations previously mentioned.

The observations for the direction of the currents at bell buoy were made during daylight of January 13, and those near buoy No. 3 on January 14, 1887. The light-house tidal record shows that on January 13 and 14 the first low water was at 8 a. m., second high water at 2.45 and 3.25 p. m., respectively, and second low water at 8 and 9 p. m., respectively. The range of the tide was nearly the same on the two days. For purposes of comparison, therefore, without much error, we can assume that the observations were made simultaneously. Plotting them as in Plate XVI, the relative strength and direction of the currents at any one time can be seen. It will be observed how the changes in direction of the currents at the bell buoy are followed by smaller but corresponding changes in direction of the currents on the bar. Plates XV and XVI throw great light on the probable cause of the bar at the mouth of the channel. A comparison of the various charts of the bar made at such long intervals, 1850, 1868, and 1886-'87, shows how staple the conditions have remained, and the prompt and complete obliteration of the channel dredged in 1883 shows clearly that an entire change must be made in these conditions before any permanent improvement is possible.

SUMMARY AND CONCLUSIONS.

(1) The volume of water passing through the northwest channel on every tide between Fort Taylor and a point 6 miles to the northwest is sufficient to make and maintain a permanent channel through the very light shifting sands ½ mile wide and 20 feet deep.

(2) The ebb and flood tides through this channel are opposite in direction and flow for nearly equal periods of time. The flood currents have the greater velocity and move a volume of water 1.6 times greater than do the ebb.

(3) Along the northern face of the reef near Key West, the ebb and and flood currents are also opposite in direction and have their maximum velocities nearly parallel to the general line of the reef.

(4) The times of maximum flow of ebb and flood are nearly coincident on the two sides of the bar proper, but vary in direction.

(5) The resultant force of the two currents gave a velocity on the bar of 1.2 feet per second north 25° west; .45 feet per second east; .77 feet per second south; and .25 feet per second west, while passing from one maximum flood velocity to the next.

(6) This interference of currents at this point spreads the volume of water coming through the clear portion of the northwest channel and, by this and by the cross-currents produced, causes the bar.

(7) All heavy waves come from a direction between the north and west. They further reduce the available depth on the bar. Their maximum height may be taken as 10 feet from hollow to crest.

(8) A breakwater or dike properly located along the west side of the bar and having a general north and south direction would afford protection from waves, would protect the channel currents from interference from the littoral currents on the north side of the reef, and would turn the entire volume of the flood currents of the northwest channel in a body across the bar, with a benficial scouring effect.

LOCATION OF DIKE.

The dike must be so located as, first, to collect and turn the flood currents of the northwest channel through one channel across the bar; second, to protect these currents from the action of the flood currents flowing along the north side of the reef; third, to protect the bar from waves from the northwest; fourth, to follow a line which will permit the greatest economy in building the dike.

To fulfill the first condition, the dike must start at a point on the flats south of the present channel lines, to prevent the flood currents from passing to the west around it. It must be so located across the false channel north of the light-house as to keep the angle of incidence of the general flood currents of the northwest channel within the limits for easy divergence, say 36° to 40° (Prof. Papers, Corps of Engineers, No. 13, p. 333, ed. 1876.)

To satisfy the second condition, the direction of the dike must make an angle of not more than 90°, measured from south to west, with the general direction of north side of the reef.

The third condition will be satisfied sufficiently by any direction east of north (the waves always coming west of north), and by prolonging the dike to the deep water. For the fourth condition, the dike should be as short as possible and located in shallow water.

A dike located on the line shown on the chart will satisfy all of these conditions, it is believed, to the best advantage. It could be prolonged farther to the south should that prove necessary.

The north channel frequently spoken of is undefined and seems to be simply the general deepening of the flats east of the bar channel. As the new channel must have the general direction of the present one under the conditions given, nothing would be gained by improving this north channel, while the length to be deepened would be greater.

Cross-section of dike.—Excepting at its northern extremity, the dike will be but little exposed to wave action. The maximum wave height north of the bar may be taken as 10 feet. This height is considerably reduced in the shoal water, and ship-masters place the highest waves on the bar at not more than 4 feet. A top width of 12 feet for the more exposed portions, and of 8 feet for the remainder, will be ample. The maximum range of tide is 4 feet. Hence, the top of the highest wave at high water may be 9 feet above the mean low-water level. As the wave action on the bar is most destructive at low tide, it is probable that the channel will be sufficiently protected by a dike with its top at the level of the highest tides. On the bar the crest of the dike may be lowered to the level of mean high water. The dike will be built of rip-rap, capped with heavy blocks from 1 to 3 tons in weight, laid by hand. The sides will be permitted to assume their natural slope under the action of the waves. This, in most instances, in the comparatively shoal harbor of this country, has been about 1 on 2. The body of the dike may be made of the soft coral rock of the keys. The capping must be heavy granite blocks.

Excepting on the bar, aprons will hardly be needed, on account of the slight depth at which the rock bottom is found. Where the rock lies at depths of more than 20 feet below the surface, it will probably be economical to build the jetty on foundation mattresses of wood, having a width transverse to the jetty of from 100 to 120 feet.

PROBABLE EFFECTS.

As before stated, the volume of flow through the Northwest Channel near its point of division, during one flood tide, lasting seven hours and fifteen minutes, was 5,424,814,427 cubic feet.

If this entire volume were diverted through the new channel across the bar, the loss of head due to the bend would be inappreciable (.1 to

.4 of an inch). If the mean velocity of flow remained the same, the cross-section required to permit the discharge in the same time would be 139,494 square feet. With a mean hydraulic radius of 16 feet, this would require a width of 2,906 yards.

If there were a loss of one-fourth of the total volume of flow, the other conditions remaining the same, with a mean hydraulic radius of 16 feet, a width of 2,179 yards would be required.

Although it is impossible that either condition would be fulfilled, yet it is evident that with the large volume of water to be accommodated, a greatly improved channel must follow the erection of the breakwater, approximating in size to the other portions of the Northwest Channel. Before a depth of 17 feet at mean low water can be attained the point of rock 1,500 feet southeast from the beacon must be removed.

There is some danger that the bar may re-form around the end of the dike. During the formation of the new channel large quantities of sand will certainly be moved, but the superior velocity of the Northwest Channel currents when confined to their new channel will probably cause this sand to be deposited on one side, or at a sufficient distance to prevent trouble.

Should the current be unable to clear its channel without aid, dredging can be safely resorted to under the protection of the dike.

ESTIMATE OF COST.

Total length of dike, 6,830 feet.	
Body of dike (riprap, coral rock):	
166,626 cubic yards, at $2.50	$416,565.00
Capping (heavy granite blocks):	
10,119 cubic yards, at $5	50,595.00
Apron (brush mattresses):	
45,533 square yards, at $1	45,533.00
	512,693.00
Engineering and contingencies:	
15 per cent. on $512,693	76,903.95
	589,596.95

If the rock must be removed, $18,000 must be added to the estimate.

The harbor at Key West is in the collection district of Key West, Fla., which is the nearest port of entry. Nearest light-house, Key West Light. Nearest fort is Fort Taylor, Fla.

The entire amount appropriated for this survey was expended.

Respectfully submitted,

W. M. BLACK,
Captain of Engineers.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., May 31, 1887.

REPORT OF MR. J. W. SACKETT, ASSISTANT ENGINEER.

JACKSONVILLE, FLA., *March* 3, 1887.

SIR: I have the honor to submit the following report on the survey of the "Northwest Channel," Key West, Fla.:

The work contemplated consisted in—

(1) A series of observations, to show more fully the character of the bottom.

(2) Current observations, to give the force and direction of the currents at different stages of the tides and under varying conditions of the winds; also, to determine the volume of discharge.

(3) Tidal observations, showing the duration of stages of the tides and the range.
(4) A number of soundings sufficient to locate any changes since previous surveys.

PRELIMINARY WORK.

The preliminary work consisted, principally, in rating the current meter. The Ellis meter, bearing maker's No. 20, was received in excellent condition, having just been refitted with iridium bearings.

The place selected for rating the meter was on the north side of Doctor's Lake, which connects with the St. John's River about 15 miles above Jacksonville, where we had an excellent opportunity to measure a base for a run of 1,000 feet in water of a uniform depth of 7 feet, and where the current was inappreciable. We proceeded to this place November 18, the party consisting of two assistants, two recorders, an engineer, and a helmsman. Having selected the line for the run, a base-line was measured on the shore approximately parallel to it. The stakes marking the run were then readjusted so that they would be equidistant from the base-line, by turning off equal angles from each end of the base, intersecting lines at 90 degrees from the other. Stakes were set 15 feet inside of these, with which two others, beyond each end of the run, were ranged. The second set of stakes was then removed, leaving the other two so as to enable the observers on the launch to know about when they were approaching either end of the run. The meter was suspended from the bow of the launch on a frame of gas-pipe constructed in accordance with your suggestions. This was arranged so that it was quite rigid, and the entire apparatus could be turned back over the bow of the launch or lowered into the water, at any time, with ease. The method of construction of this frame is shown in plate 1.* When in use the meter was 6 feet ahead of the bow of the launch and about 3 feet below the surface. An observer with a transit was stationed at each end of the base line, which was 1,000 feet long, and one at the register, with another, with a time piece, on the launch. One Leclanché cell was used. In the field work sometimes two were required. When the observers, the engineer, and the helmsman were in readiness, the launch approached the upper end of the line, getting carefully in range with the stakes at the other end and prepared to run with a uniform speed. When within about 50 feet of the stake marking the end which the launch was approaching, the observer at that end of the base line called "Ready." The man recording the time began tapping the face of the watch with his pencil at each second; the pencil being up at half seconds, he was enabled to note the time to the nearest half second; at the same signal the observer at the register "took up the beat." At the instant the pipe on which the meter was suspended passed the cross wire of the telescope the transit man called "Time," sharply and distinctly. The time and the reading of the register were noted. The same was done at the other end. The velocity of the launch varied from 1.2 to 8.3 feet per second.

The day selected for the rating was nearly calm and the water was very smooth. Fifteen round trips were made, going down and back, so as to eliminate the effect of current, if any existed. Taking the mean of each trip down combined with the next trip back, and the mean of each trip down combined with the previous trip back, twenty-nine results were obtained. These were plotted with reference to a system of rectangular co-ordinates, the velocity in feet per second (v') being the abscissa, and the revolutions per second (n) the ordinate. The line showing the relation between them is practically a right line, whose equation is $v'=an+b$, in which a is the tangent of the angle which the line makes with the axis of abscissas, and b the distance from the origin to the point of intersection with the axis of ordinates. (See Plate A.) Substituting the observed values of v' and n in the above equation, forming twenty-nine equations, and each one being compared with all the others, 435 values for each a and b were obtained. The method of least squares was applied to these, and 3.772 was obtained for the value of a, with a probable error of 0.00099, and 0.091 for b, with a probable error of 0.00402.

Preparations being complete, the party left Jacksonville for Key West, December 1. On account of the weather and the delay in securing boats, the field work was not begun until December 10. At this juncture the party consisted of two assistants, two recorders, one leadsman, two tidal observers, and five boatmen. We had a 15-ton schooner, a yawl-boat, and a skiff.

Tide-gauges.—A box tide-gauge was established at the Northwest Light, which was in successful operation during the entire survey. A gauge was also established at Fort Taylor, the object being to obtain the difference in the times of high and low water between the two places. No tidal constant is given for the Northwest Bar in the Coast Survey tide tables.

Base line.—Not being able to identify, with a certainty, any convenient Coast Survey stations, I decided to measure a base line on the flat lying north and east of Cottrell's Key. This was done by driving 3-inch by 4-inch stakes firmly in the sand 100 feet apart, with the tops to the same level and with large copper-tack centers, o which knife marks were made to measure from. A 100-foot Chesterman steel tap was used, care being taken to have a uniform tension, and the result was correcte for temperature and the catenary. The base, as corrected, was 6,999.30 feet long.

---

* Omitted.

Signals.—Platforms were erected for the transits at East Base and West Base. Els where tripods were built of 4-inch by 4-inch scantling, 25 feet long, surmounte by a flag-staff made by nailing together 1-inch by 3-inch strips, 25 feet long—nailing the edge of one on to the side of the other. These were built from the schooner' deck. The schooner was anchored fore and aft and the signal built on the windwar side. The scantling, lashed together at the top, were hoisted at the rigging and the lower ends spread by leading one forward, one aft and one abeam. The one abea was managed from a small boat anchored abreast of the schooner. They were the lowered to the bottom, where their own weight would keep them. The ends having previously been well sharpened, they were driven down by a heavy maul and the thoroughly lashed, spiked, and braced.

Triangulation.—Stations East Base, West Base, and Northwest Light were occupied by transits. To the principal triangulation points the angles were repeated at least five times and both verniers read. The remaining stations were occupied with sextants, each station being occupied by two observers separately. From every station angles were observed to the two sides of all the keys visible as well as to the light-houses and the buoys.

Soundings.—The soundings were all taken from the schooner while sailing. Whenever possible natural objects were used for ranges. The principal lines radiate from the light-house. As a matter of course the wind did not serve satisfactorily at times. This resulted, as was expected, in getting some of the lines crowded; but it was the only way to cover such a large area, in the limited time, without a steamer. A small steam-launch would not have been safe on this bar, exposed as it is to the open Gulf. The soundings were located with a transit at the light-house and a sextant on board the schooner; the observer with the sextant being stationed as near the leadsman as convenient, and the transitman observed the sextant. The location of the sextant in reference to the lead line was duly noted and recorded.

Topography.—The only topography taken was that of the coral reef extending from the west of Cottrel's Key towards the light-house. This was located by triangulation.

Current observations.—In using the current meter, the yawl-boat was anchored by three 100-pound anchors. One line led directly forward and one from each side quartering aft. The bow of the boat was towards the waves. The meter was clamped on to a piece of ½-inch gas-pipe, 3 feet in length, the lower end of which was loaded with 10 pounds of lead. To the upper end of the pipe a graduated line was securely fastened in such a manner as to be easily detached when required. The meter cable, a ⅝-inch tarred manilla line, which was fastened to a 100-pound mushroom anchor on the bottom, was rove through the gas-pipe and led up to the boat together with the graduated line, by which the meter was suspended at the required depth.

An apparatus had to be designed to counteract the rise and fall of the boat in the sea-way. The method of construction of the one used is shown in Plate II. It consisted of a frame, with 2 arms, 10 feet long, working outside of the boat. The arms were about 7 feet apart at the forward end and 2 feet at the after end, with a cross piece at the after end and one about 4 feet from the forward end. The second cross piece rested in chocks on the gunwale of the boat and the other swung clear of the stern. Counterpoises weighing about 50 pounds each were placed on the forward end of each arm. The meter cable, etc., was fastened to the cross piece at the after end. The arms were halved into and rested on the longer cross piece, and the shorter cross piece was halved into and rested on the arms. It was fastened together by pins which could be easily removed, and the frame taken apart and stowed in the boat. The counterpoises were fitted over the arms and fastened with a pin, for which holes were provided at intervals along the arms—the weight being slipped forward or back, thus adjusting it to give the proper strain on the meter cable. With this arrangement, practice demonstrated that observations could be conducted without hinderance when the boat rose and fell as much as 6 feet.

At each station occupied, observations being begun at slack water if convenient, readings of the register were noted every five minutes and the meter was kept at mid-depth until it was estimated that the maximum velocity of that tide was reached, when observations were begun at different points in the vertical plane. The meter was retained at each depth for two minutes, and the reading of the register noted each minute. The results of these observations were plotted on cross-section paper, the mean of the two results at each depth being used, and a curve constructed that would coincide with these points the nearest. This curve was adopted as the vertical velocity curve of that station. The ratio of the mean velocity to the mid-depth velocity, as determined from the curve, was used as the coefficient for the reduction of all mid-depth velocities at that station. The vertical velocity curves for the different stations are shown in Plates III to VII. From each curve results are taken for each of 0.2 foot in depth and the mean velocity for the stations determined from these results. The velocities at different depths are taken off graphically as required. A comparison has been made between the mean velocity (Vm) and the mid-depth velocity (V ½ D), between the depth of mean velocity fillet (M) and the whole depth (D), and between the depth of maximum velocity fillet (d_1) and the whole depth. The mean results of these comparisons for all the stations are, viz:

$$\frac{Vm}{V\frac{1}{2}D}=.925 \qquad \frac{M}{D}=.597 \qquad \frac{d_1}{D}=.193$$

The results for each station are shown in table 1.* The first current observations were taken with a view to ascertain the volume of discharge during the ebb and flood tides in the main channel. The place selected for the cross-section is the last part of the channel that is comparatively well defined. In view of the impossibility, with the means at hand, of taking simultaneous observations at different points in the section so as to obtain the horizontal velocity curve, it was determined to take careful observations at the deepest part of the channel, assuming that to be the point of maximum velocity, under circumstances that would give about an average discharge, taking a sufficient number of observations in a vertical plane to determine the vertical velocity curve, and deduce therefrom the horizontal curve. It was assumed that the horizontal curve of velocity in this comparatively confined channel was approximately the same as the vertical curve at the point of maximum velocity of the cross-section. (See Humphrey's and Abbot's Report on the Mississippi River, edition 1876, page 212.)

In computing the discharge, each tide was divided into ten stages of equal duration, and the cross-section into seven divisions of such size as the shape of the bottom required. The coefficient used in reducing the velocity at the meter stations to that at each division is the ratio of the velocity on the vertical velocity curve, at the same proportionate distance from the axis of the curve as the middle point of the division was from the meter station to the velocity at the axis.

The data for the construction of tables 2 to 9* which give the mean velocity, the discharge for each division for each stage of the tide, and the total discharge was obtained in this way.

Distribution of meter stations.—Station 1 was situated in mid-channel, about 2 miles from the Northwest Light, toward Key West, and was occupied through the ebb and the successive flood tides, the observations being complete.

Station 2 was in the channel on the bar near Buoy 3. The ebb tide only was observed.

Station 3 was near the bell buoy. Both tides were observed.

Station 4 was on the bar near Station 2. Both tides were observed.

Station Beacon was on the southwest side of the channel, where it makes the abrupt turn to cross the bar. A heavy sea prevailed during the time observations were made at this station.

Direction of current.—The results of the mid-depth observations at each station, reduced to mean velocities, have been plotted with co-ordinates of time and velocity, and are shown in Plates VIII to X.† It will be noticed that the direction of the current is noted at intervals on the ordinates. An examination of these will show that at the stations on the bar and at the bell buoy, which are not in a confined channel, the direction of the current varies during the ebb and flow through the entire arc of the horizon. To show this, as well as the velocities in the different directions, graphically, the plan of plotting them in terms of direction and velocity on a diagram of concentric circles with radii referred to the meridian, was adopted.

The observations at stations 3 and 4, plotted thus, are shown in Plate XV.

This diagram also shows that the general direction of the currents on the bar is approximately in the direction of the prolongation of the axis of the main channel as it comes from Key West, and that the currents off the bar are evidently modified by the ebb and flow through the large breach in the general line of the main reef east of the Marquesas Keys, called Boca Grande Channel, changing it in fact to a littoral current, flowing transversely to the direction of the current on the "bar," particularly during the flood.

The flood-tide current is stronger than the ebb, which finds easier exit through the Boca Grande Channel, owing to the salient position of the Northwest Bar, and the comparative inferiority of the size of the channel.

Tidal observations.—The tide-gauge at the Northwest Light gave excellent results even in the most stormy weather, and was observed by men in whom confidence could be placed. It was observed day and night during the entire survey. Table 10* shows the time and height of each high and low water, the maximum, minimum, and mean range of the tide, the time of the moon's meridian passage, its declination and phases, the lunitidal interval, and the direction and force of the wind for each day from December 10 to January 15.

---

*Omitted.

†Omitted; Plates XV and XVI substituted.

On Plate XIV the high and low waters are plotted with reference to co-ordinates of time and height, showing also the times of the moon's meridian passage and its phases.

In reference to the diurnal inequality, the table and plate show that the high water nearest the time of the moon's meridian passage is higher and the following low water is lower than the preceding and following one when the moon's declination is north, and the reverse when south. They also show that the wind has very little if any effect on the height. Certain irregularities in regard to the time are probably caused by the wind.

The mean diurnal inequality in the heights of the low waters is nearly three times as great as it is in the height of the high waters.

The difference between the mean of the highest high waters and of the lowest high waters is 0.43 feet.

The difference between the mean of the highest low waters and the lowest low waters is 1.15 feet.

The plane of mean high water is 2.63 feet above the plane of mean low water. The greatest range of the tide observed, 4.8 feet, was on December 13, with almost a calm, and the least, 0.73, was on January 4, with a strong north wind.

The greatest variation in the height of two successive high waters, 0.88 feet, was on December 11, and of two successive low waters, 1.75 feet, on January 12. In both instances it was almost calm.

The mean lunitidal interval during the time of observation was 11 hours and 24 minutes.

The mean of the differences in the times of high water between Fort Taylor, at Key West, and the northwest light is 2 hours 13 minutes, and of low water 1 hour 39 minutes, it being earlier at Fort Taylor. During the time of observation this interval seemed to vary with the moon's declination as follows: In reference to high water, when the moon was at its greatest declination north, it amounted to about 1 hour, when at its greatest declination south, as much as 4 hours; in reference to low water, when at its greatest declination north, about 30 minutes, and when at its greatest declination south, about 3 hours 20 minutes.

Winds.—Through the courtesy of the United States Signal Service observer at Key West I was enabled to obtain a copy of the record of the observations of the direction of the wind, taken three times daily, from 1871 to 1886, inclusive. It is found that the frequency of occurrence of the winds from the different directions is about in the following proportion, viz: West 1, calms 1.1, southwest 1.4, south 1.7, northwest 1.9, north 6.2, southeast 5.1, northeast 7, and east 9.2.

The prevailing winds during each month are as follows: January, northeast; February, east-northeast; March, northeast to southeast; April to September, east; and October to December, northeast. In four of the sixteen years considered, north winds prevailed in January and February. The northerly winds have the greatest average velocity.

Waves.—In all the observations taken of the direction of the waves, in calm weather and in storms, they invariably came from some point between the north and the northwest.

For instance, the record of observations at Station Beacon January 11, at 10 a. m. shows that a stiff breeze was blowing from north 22 degrees east, with the current setting north, while the waves, 3 feet in height (6 from crest to hollow), with a period of 3 seconds, were coming from north 20 degrees west.

During a strong "norther" there is no place on the "bar" free from breakers. This would indicate that the waves are at least 6 feet in height.

Character of bottom.—The bottom consists of calcareous sand, composed of fine particles of broken coral and shells and oolitic rock of coral formation, of both of which specimens are submitted.

On the bar, where the bottom is exposed to the action of the waves, the sand is rather compact, so much so that it was only with difficulty that a steel-pointed iron sounding-rod, ½ inch in diameter, could be forced down into 3 or 4 feet. On the flats the sand is softer, partaking more of the character of marl. The rock is quite soft. It is easily cut with a hatchet or crushed with the heel. I am told that it hardens considerably on exposure to the atmosphere.

As far as our observations and those of previous surveys have extended, rock occurs nowhere in the line of the present channel at a less depth than 18 feet, with one exception, and that is a point about 1,500 feet southeast of Station Beacon.

---

* Omitted.

There is a reef of solid rock beginning at a point about 3,800 feet west of the lighthouse and extending thence southwest past Cottrell's Key. This reef would be an excellent base for a jetty running thence across the bar on the west side of the channel.

The North Channel.—In regard to the North Channel, which is the expanse of water, of nearly uniform depth, to the east of the buoyed channel across the northwest bar, an examination of the contours shows that the cost of opening a channel through it would be much greater than through the present channel. As to the question of permanent improvement, its position in relation to the main channel practically debars it from consideration.

General observations.—The survey was made under some disadvantages, the chief of which was the continued bad weather, which, however, is nothing unusual at that time of the year. Fortunately enough it happened so that the days on which the soundings were taken were remarkably favorable and the water very smooth. I have every reason to believe that the results are sufficiently accurate to develop a project for the permanent improvement of the channel, which I deem quite practicable, also to estimate the approximate cost thereof.

I take pleasure in calling attention to the very efficient services of assistants F. W. Bruce, J. G. Gibbes, jr., and Roland Woodward, and to the zeal and energy which they displayed in the performance of their duties.

The map of the survey, 10 tables and 15 plates, are herewith submitted, viz:

*Table 1. Comparisons of properties of velocity curves.
*Tables 2 to 9. Discharge at cross-section No. 1.
*Table 10. Tide-table, Northwest Light.
*Plate I. Outrigger for rating current meter.
Plate II. Counterpoise frame for current meter.
Plates III to VII. Vertical velocity curves.
*Plates VIII. to X. Mean velocity curves.
*Plate XI. Cross-section No. 1.
Plate XV. Diagrams of direction and velocity.
*Plate XIV. Rise and fall of tide at Northwest Light.
Plate A. Plotted results of rating meter.

Very respectfully, your obedient servant,

J. W. SACKETT,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers.

COMMERCIAL STATISTICS, PORT OF KEY WEST, FLORIDA.

[Furnished by Mr. George Lewis and Mr. A. F. Tift, of Key West, Fla.]

Number and character of vessels entering and clearing at the port of Key West, Fla., during 1886.

Vessels.	Foreign, in cargoes.		Coastwise, in cargoes.		Foreign, in balast.	
	In.	Out.	In.	Out.	In.	Out.
Steamers	184	67	144	136	13	132
Barks	......	......	6	5	2	......
Brigs	......	......	3	1	......	......
Schooners	94	54	114	94	9	54
Total	278	121	267	236	24	186

* Omitted.

CUSTOM-HOUSE RECEIPTS.

Duties	$602,354.4
Tonnage tax	760.9
Marine-hospital tax	36.9
Fines, penalties, and forfeitures	3,641.7
Inspection of steam vessels	91.4
Immigrant fund	2,589.5
Official fees	3,986.2
Total	613,461.19
Amount of tobacco imported (raw)	717,604.09
Miscellaneous imports (foreign)	125,262.59
Total internal-revenue tax on tobacco collected a Key West, Fla., in 1886,	217,831.37

Number and character of craft engaged in the traffic of Key West Harbor, Fla.

	No.	Tonnage.
Steamers (freight, passenger, and towing)	18	4,039.70
Schooners	154	3,865.06
Sloops	5	44.19
Total	177	7,948.95

Value of exports, $529,720.

Entrances and clearances at the port of Key West.

Description.	Entrances.		Clearances.	
	No.	Tonnage.	No.	Tonnage.
American vessels from foreign ports	234	90,845	225	76,264
Foreign vessels from foreign ports	57	7,169	54	6,711
Coastwise	278	280,954	264	259,601
Total	569	378,968	543	342,576

LETTER OF MR. A. F. TIFT.

KEY WEST, FLA., *May* 9, 1887.

DEAR SIR: Herewith I beg to hand you a list of vessels to my consignment that have used the Northwest Channel in entering and leaving our port for the year commencing April 1, 1886, and ending March 30, 1887.

I forward this as promised, in connection with the subject of your letter of 15th ultimo, the receipt of which I have already acknowledged.

* * * * * * *

Your plan of deepening the Northwest Channel entrance to our harbor is a capital one, and I so heartily approve of your suggestions that I have talked the matter up thoroughly (since the receipt of your letter) with many of our leading citizens and have enlisted their co-operation in the great work, they agreeing fully with me in its feasibility and a complete realization of your undertaking.

That the deepening to a depth of 17 feet of the Northwest Channel entrance to our port will be of incalculable benefit to commerce, not to one particular section only, but to the whole United States, is beyond a doubt, and will increase the tonnage using this passage the last year at least one-third, particularly when it is charted and otherwise made generally known that its depth has been increased to 17 feet.

Trusting that I may hear further from you upon this subject, I am,

Yours very truly,

A. F. TIFT.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

ist of vessels to the consignment of A. F. Tift that have entered and sailed through the Northwest Channel entrance to the port of Key West, during the year commencing April 1, 1886, *and ending March* 31, 1887.

Names of steamers.	Total arrivals and departures.	Total arrived tonnage.	Total sailed tonnage.
scotte hitney tchinson rgan	303	167,567.96	166,573.65

he cargoes consist of fruit, tobacco, cigars, general merchandise, etc.

LETTER OF MR. WM. CURRY.

KEY WEST, FLA., *April* 28, 1887.

EAR SIR: The arrivals at my wharves for one year ending April 1, 1887, of
sels that entered port through the Northwest Channel was 274, of an average ton-
ge of 100 tons each. About one-half of this number were lumber-loaded vessels from
sacola and the Mississippi Sound; the balance were from various ports on the
rida coast. This estimate does not include any fishing or sponge vessels of
ich there are near 100, from 10 to 20 tons each. If the Northwest Channel should
deepened sufficiently there is no doubt that it would be of great benefit, and
uld be used by all vessels trading to Gulf from northern ports, thereby saving
e and distance and reducing the dangers of navigation around the Tortugas.

Very respectfully,

WM. CURRY.

r. GEORGE LEWIS.

LETTER OF MR. JOHN JAY PHILBRICK.

KEY WEST, FLA., *April* 26, 1887.

y DEAR SIR: Referring to the letter of Capt. W. M. Black, of which you sent me
py, covering the question of improving the Northwest Channel, I beg to state
t the importance of the work is so great and its advantages so far-reaching and
eficial to the commerce of the world that I hardly feel competent to present them
h full force. To carry out the wishes of Captain Black towards gathering infor-
tion, statistics, and prospects bearing upon the construction of a jetty or break-
ter running from the Northwest Light-house to deep water, as I understand them,
first facts to be shown are the character of vessels which use the channel,
ir number and tonnage, and the ports to and from which they are bound. The
racter of vessels now using this channel is naturally such as will be accommo-
ted by the limited depth of water, and varies from small vessels that draw no more
n 9½ feet to large vessels that are built to draw no more, but which if built for
er waters would be much deeper, both for purposes of safety and profit as well as
atisfy the demands of scientific construction.

ommencing with the nearest port from which vessels sail for Key West, we have
cattle trade from Punta Rassa, serving as a shipping port for the entire South
rida country and carried on by both steamers and schooners. When the demand
ood in Cuba this trade amounts to $800,000 per annum, and the principal losses in
s business arise from the inability of the vessels to cross the present Northwest
r, during the six stormy months of the year. The country about Punta Rassa, in-
ding the cities of Fort Meyers, Saint James, Trabue, etc., is rapidly filling up, and
interests becoming more important every day. The latter port is already the ter-
nus of the Florida Southern Railway, and the question of establishing a line of
amships from this terminus to Cuba and the West Indies will depend almost en-
ly on the facilities afforded by the Government in the use of this channel.

Proceeding further up the coast the business of Tampa, as the terminus of the So Florida Railroad, next presents itself. This business embraces the steamers of New York and Havana Fast Mail Line, as well as those of the Tampa and Na Mail Line carrying mails from Europe and the United States to the British Baha and West India Islands. The former company has very expensive steamships r ning as well as the latter; vessels that were built especially for the service, an the building of which the owners were hampered by the shoalness of this bar.

The traffic of these steamships is enormous, carrying each year cargoes value upwards of $900,000, and consisting of general supplies from the North, with valu freights of tobacco and West India products back.

The deepening of this channel is of the greatest importance to this line, especi of all those now using it. The peculiarities of the route of these vessels make it d cult to construct ships calculated for the work, as the present depth of water in Northwest Channel will not allow the construction of a ship suitable for the sea ch nel and the rough and deep waters of the Gulf. A combination of steam-boat a steam-ship is requisite, thus hampering and restricting the projectors of the enterpri Further up the coast and at Cedar Keys, the terminus of the Florida Railway a Navigation Company, a line of steamers finds its southern connection and out through this channel to Key West and the tropics, and the value of their cargoes a traffic is quite considerable. From Apalachicola, Pensacola, Mobile, and Pascago a very large number of vessels are constantly engaged transporting lumber to tl market and those beyond, covering a business of upwards of 20,000,000 feet duri the last twelve months. From the nature of the channel these vessels are necessar small and of light draught, heavier vessels and consequently more profitable or being shut out from the business.

From New Orleans a wealthy line of steamers running as far as Havana, and car ing valuable cargoes both ways, consisting of general food supplies out and sug tobacco, and fruit back, and embracing values of $7,500,000 per annum, make use this entrance, and are restricted in their construction and capacity by the same cau that affect the Havana Fast Mail Line.

The above, in a general way, covers the first query in Captain Black's letter.

Referring to his other question as to the probable increase of tonnage using t channel, should it be improved to a depth of 17 feet, I would state that the fie opening in this direction is comprehensive and far-reaching, and offers such opport nities and inducements to the general commerce of this country and of the wo that I hesitate to attempt to measure its effects. To all vessels going to and fr the Gulf ports of the United States whose draught of water was adapted to a 17-fo channel, this one would offer a saving of 50 miles in distance, together with immuni from the dangers of the Florida Reefs for 60 miles, and the records of the Unit States admiralty court will show that the disasters to commerce during the past t years have been as numerous and show as great a loss of property in this section 60 miles as in the entire balance of the reef. To begin with, such an improvement this channel would not only render it safer for the vessels that now use it, but wou enable the Tampa, Plant and Cedar Keys Steamship companies to build vessels b ter calculated to handle their largely increasing business and allow steamers a other vessels from the West Indies of heavy draught to connect directly with the d ferent railroad termini in South Florida ports. It would also attract and offer a vantages of saving and economy to all vessels passing from the northern ports of tl continent and from Europe and South America to the large lumber ports of Apalac icola, Pensacola, Mobile, and Pascagoula by cutting off a distance of 100 miles in tl passage to and from the Gulf of Mexico, or the enormous commerce between Pens cola and the Northern ports of the United States and Europe, embracing many hu dreds of vessels annually, or that between Mobile and New Orleans, and the sa points covering a large portion of the business of the world in lumber, cotton, grai stores, and naval stores. It would be impossible without an extended research to c culate the saving in time and actual running expenses that this 100 miles would off and this figure only represents the saving to steam vessels; to sailing ships passi through the Gulf seeking one of the above ports, with a westerly wind, the cutti off of 50 miles at this point would place the vessels on a fair course and the savi would represent days and months of time in beating with a head-wind against t Gulf Stream.

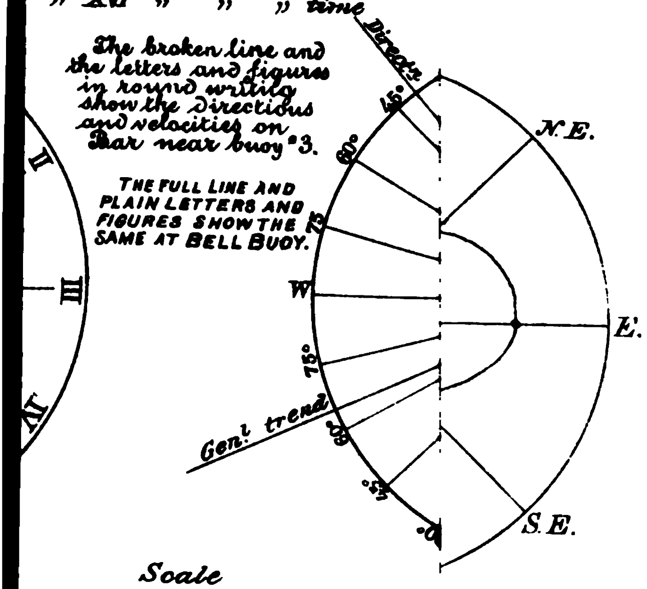
As you are leaving so soon for your home I shall not have time to prepare some st tistics which would show more fully the practical value of the improvements und consideration, but would like to put them before you as early as possible.

Yours, very truly,

JOHN JAY PHILBRICK.

GEO. LEWIS, Esq.,
Key West, Fla.

ive Velocities and Directio
Flood and Ebb Currents
at
Stations 3 & 4
arranged
Plate XV with respect to direction
" XVI " " " time



The broken line and the letters and figures in round writing show the directions and velocities on Bar near buoy #3.

THE FULL LINE AND PLAIN LETTERS AND FIGURES SHOW THE SAME AT BELL BUOY.

Scale
asured radially = 0·1 velocity per

O 5.

IMPROVEMENT OF CALOOSAHATCHIE RIVER, FLORIDA.

The Caloosahatchie River rises in the saw grass region west of Lake Okeechobee and flows west into San Carlos Bay. Between the mouth and Fort Thompson, 20 miles west of Lake Okeechobee, the river-banks are generally high and the country bordering the river is covered with a dense growth of large trees, principally pines, palmettoes, and oaks. East of Fort Thompson the low saw-grass region begins. The entire river valley as far down as Alva, about 30 miles by river below Fort Thompson, is more or less subject to overflow by the water coming from the Okeechobee Basin. For 17 miles from its mouth the river is broad and has a channel depth of from 6 to 20 feet, with the characteristics of an estuary. This portion of the river is much obstructed by oyster bars. Great beds of snags obstruct the upper river. From Alva down, the country is being settled rapidly for the culture of sugar-cane, pine-apples, cocoa-nuts, oranges, limes, and lemons. Fine cattle-ranges exist along the upper river.

Fort Myers, a depot of supplies during the Seminole war, is a thriving town 15 miles from the mouth.

Under the laws of the State of Florida, the Atlantic and Gulf Coast Canal and Okeechobee Land Company is engaged in draining the Okeechobee Basin, having authority from the State to cut canals and use the natural water-ways for this purpose. A canal, with a minimum cross-section of 22 feet by 5 feet, has been opened from Lake Okeechobee to the headwaters of the Caloosahatchie River, and through them as far as the western end of Lake Flirt. A rocky ledge at Fort Thompson has been removed and four cut-offs have been made across the worst bends below Fort Thompson. These operations, with work done on the Kissimmee River, which flows into Lake Okeechobee, have lowered the level of the water on the lakes at the head of Kissimmee River, but have had no effect on the level of Lake Okeechobee. The works were not intended for the benefit of navigation, but they have incidentally opened a water route about 300 miles long from the Gulf of Mexico to the interior of Florida, via San Carlos Bay, the Caloosahatchie River, Lake Okeechobee, the Kissimmee River, and Lakes Kissimmee, Cypress, and Tohopekaliga. With the exceptions of the cut-offs, which on account of their bad location are an injury to the river, the work of the company has been beneficial to navigation. Steamers now pass over the route at irregular intervals. It is reported that regular trips will be made during the coming year.

An examination of this river with a view to its improvement was made in March and April, 1879. A report thereon, dated August 27, 1879, with a plan of improvement, is printed as Appendix J 17, Report of the Chief of Engineers for 1879.

The project adopted in 1882 called for deepening the channel by dredging from the mouth to Fort Myers, so as to give a depth of 7 feet at mean low water for a width of 100 feet.

Operations were carried on under appropriations made by Congress in 1882 and 1884, aggregating $10,000. The work was done by contract, and in 1885 the channel was reported completed.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

By act approved August 5, 1886, $4,000 were appropriated for the improvement of this river. On examination it was found that the improvement of the upper river by the removal of snags and overhanging trees was what was most desired by the citizens of the Caloosahatchie Valley. A portion of these citizens fear that the work of the Atlantic and Gulf Coast Canal and Okeechobee Land Company, mentioned above, may injure their lands by overflows caused by the increased volume of water turned into the river. They were very desirous that no improvements should be made by the United States which would tend to increase this danger.

No detailed map of the river has ever been made, and but little information could be obtained concerning its length, cross-section, or fall. Accordingly it was determined to expend $2,000 of the amount available in making a survey of the river and to use the remainder in clearing away the obstructions in the upper river, beginning at a point below the lowest cut-off mentioned above, which their chief engineer stated was as far as the company expects to extend its operations.

The field-work of the survey was begun March 26, 1887, and completed on May 24. A portion of the survey has been plotted. Snagging operations were carried on during May and June by hired labor. On June 27 this work was stopped by high water. The river was cleared for a distance of 4½ miles above Fort Denand in a reach which gave the greatest trouble to pilots.

Between the point where work ceased and Fort Meyers it is estimated that there are 500 snags and 4,000 overhanging trees yet to be removed before the channel is entirely clear. This work, with a small amount of work in straightening and deepening the channel at the Beautiful Islands, the head of the estuary, would clear the river for navigation by boats drawing 4 feet of water between Forts Meyers and Thompson, excepting in the short reach immediately below Fort Thompson covered by the works of the Canal and Land Company. The estimated cost of doing this work is $11,000.

The map of the lower river is far enough advanced to show that there is a continuous channel 100 feet wide between the 6-foot contours across the bars at the mouth.

The channel is crooked, but it has been marked sufficiently with stakes to permit steamers to follow it easily.

No further work is needed here at present, though as the oyster bars are continually growing the improvement can not be regarded as permanent.

Caloosahatchie River is in the collection district of Key West, which is the nearest port of entry. Nearest light-house is Sanibel Island light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1886, amount available		$543.41
Amount appropriated by act approved August 5, 1886		4,000.00
		4,543.41
July 1, 1887, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1886	$2,789.81	
July 1, 1887, outstanding liabilities	798.32	
		3,588.13
July 1, 1887, amount available		955.28
Amount (estimated) required for completion of existing project		13,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		13,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS—CALOOSAHATCHIE RIVER, FLORIDA.

[Furnished by Mr. Peter Nelson, Fort Meyers, Fla]

The incoming freight during the fiscal year ending June 30, 1887, consisted of lumber, machinery, and general merchandise; estimated value, $70,000. The outgoing for the same period consisted of cattle, hogs, honey, sirup, and general farm produce.

The whole of the trade is dependent on the water carriage. It would be increased at least 25 per cent, were the improvement completed according to the existing project. During the past fiscal year there has been an increase of 10 per cent. in the river business.

Gardening and truck farming have decreased, owing to the irregularities of the shipping facilities. The production of oranges, etc., is rapidly increasing. A large percentage of the imports is of lumber.

O 6.

IMPROVEMENT OF PEASE RIVER, FLORIDA.

Pease River (Talakchopoko, Hatchee, or Peaseating Creek) rises in the northeastern part of township 30 south, range 26 east, and flows northwestward and westward to the middle of section 33, township 29 south, range 25 east, where it makes a junction with Saddle Creek, flowing southeastward from Lake Hancock. Thence its course is southwest to Hickory Bluff, where it empties into Charlotte Harbor, making about 15 miles westing and 66 miles southing. It is fed by numerous lakes in the central part of Polk County. The principal tributaries in the east are Little Charley, Tsala-apopka, Josh, and Prairie creeks, and on the west Saddle, Whitten, and Chilocohatchie creeks. Besides these streams, wide areas of swamp and hammock lands, immediately bordering the river, and the more elevated adjacent pine lands, are covered during the rainy season, in July and August, with shallow pools of water, which are discharged for the most part into Pease River. The stream, therefore, exhibits much variation in its stages of water, the range between extremes at Fort Meade being about 17 feet.

For the last 10 miles of its course, the river has the characteristics of an estuary, and is, in fact, the prolongation of Charlotte Harbor. Vessels drawing 10 feet of water can enter the mouth. Five feet can be carried to Cleveland, 7 miles from the mouth.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in rock excavation, removing snags, and clearing the banks of overhanging trees, so as to enable boats drawing 2 feet of water to navigate during about half the year; minimum channel width to be 30 feet.

OPERATIONS PRIOR TO JUNE 30, 1886.

Operations were carried on by hired labor under appropriations made in 1881 and 1882, aggregating $11,000. The work was done over a reach of 64 miles, beginning at the mouth. The channel was cleared through the distance traversed, but with no practical results. There is no regular navigation in the upper river, and the stream has again become choked with bars and fallen trees.

It is estimated that an annual expenditure of $2,500 would be required to keep the river clear to the extent required by the project, should the improvement be completed.

OPERATIONS IN FISCAL YEAR ENDING JUNE 30, 1886.

In the act approved August 5, 1886, Congress appropriated for "improving Manatee and Pease rivers, Florida continuing improvement, $13,000, of which $5,000 may be expended on Pease River."

To determine the proper allotment of this appropriation a comparative examination of the two rivers was made, with a view—

First. To the improvements required;

Second. To the cost of these improvements; and

Third. To the commercial interests involved.

Pease River is fully described in the report of the Chief of Engineers mentioned above, and to this report attention is respectfully invited. Owing to the constantly varying water surface, the depth which could be held through the year is very limited, and a large annual expenditure would be required for maintenance of the cleared channel. The country bordering the stream is thinly settled. In 1885 Manatee County, in which the greater part of the stream lies, had a population of 5,484, with an area of 2,996,000 acres, as reported in the Florida Annual of 1886. The principal towns along the portion of the river covered by the project are Punta Gorda (Trabue), Cleveland, Liverpool, and Fort Meade, situated ½, 7, 15, and 160 miles from the mouth, respectively. Inquiry showed that with the exception of the Charlotte Harbor steam-boat line, which makes landings at Punta Gorda and Cleveland, and occasional coasting vessels which ascend as high as Liverpool, there is no river commerce whatever. As the Florida Southern Railroad skirts the river from Bartow to its mouth, there was no necessity for any river traffic, save as an auxiliary or possible competing line, or as an attraction for tourists.

The inhabitants of the towns of Punta Gorda, Cleveland, and Liverpool desire the deepening of the stream at the mouth. Four projects were suggested by the citizens most interested, viz, first, to deepen the bar at the mouth, so as to make a 12-foot channel to the wharves at Punta Gorda; second, to make a 9-foot channel as far as Cleveland; third, to make an 8-foot channel as far as Liverpool; and, fourth, to clear the river according to the existing project as far as Fort Meade.

The cost of these projects, as well as could be ascertained in the absence of detailed maps, is $50,000, $55,000, $27,000, and $25,000, respectively. As the commercial interests of the section are almost entirely undeveloped, and the maximum amount available was too small to be of any service in Pease River, and its deduction from the total amount appropriated for the two rivers would leave a sum so small as to prevent effective work in Manatee River, it was decided to expend $2,000 in making a complete survey of the river, from which accurate estimates could be made, and to allot the remaining $11,000 to the improvement of Manatee River.

The notes of a survey, made in 1881, between Port Meade and Liverpool, were plotted, and on May 25 a party started the survey of the lower river. The field work was completed as far as Liverpool on June 15. This will be plotted. The survey of the upper river will be completed as soon as the cool weather of the fall will permit effective field work. A project can then be submitted. Existing facilities seem to be sufficient for the present needs of commerce. Many settlers have come to this portion of Florida within the past year and the commerce is developing.

I am indebted to Mr. F. M. Durrance, deputy collector, for the commercial statistics of Punta Gorda. Mr. Durrance does not include in his figures the local trade to the Caloosahatchie River.

Pease River is in the collection district of Key West, and Key West is the nearest port of entry. Nearest light-house is Sanibel Island, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1886, amount available	$484.07	
Amount appropriated by act approved August 5, 1886, $13,000 for Manatee and Pease Rivers, of which there was allotted for Pease River	2,000 00	
		$2,484.07
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,357.27	
July 1, 1887, outstanding liabilities	143.54	
		1,500.81
July 1, 1887, amount available		983.26
Amount (estimated) required for completion of existing project		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS, PORT OF PUNTA GORDA, FLORIDA.

The exports consist of about 400 head of cattle, and 6 schooner-loads of fish; estimated value, $10,000. The trade in this locality is almost entirely dependent on the water carriage, and would be doubled should the existing project be completed.

The increase in the total trade in the fiscal year ending June 30, 1887, was about 200 per cent.

Within the last twelve months the Florida Southern Railroad has been built to this port. Two large wharves have been constructed, one of which is 3,800 feet long.

Punta Gorda, being in the collection district of Key West, all reports are kept at Key West, Fla.

O 7.

IMPROVEMENT OF MANATEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on under only one appropriation of $12,000, made in act passed August 2, 1882.

Manatee River rises in the southern part of Florida and flows in a westerly direction, emptying into Tampa Bay on its southern shore. For a distance of 12 miles from its mouth it has the characteristics of an estuary. For 10 miles the settlements along its banks are almost continuous. They comprise the towns of Manatee, Hendrix, Ellenton, Palmetto, Bradentown, and Palma Sola. Oranges and vegetables are raised in large quantities. From the fine ranges along the upper river hides, wool, and sheep skins are exported.

In the estuary the general depth of the river varies from 7 to 20 feet. At the mouth there is a long shoal with a depth of 7 feet. Between Palmetto and Manatee there is another bar covered by from 3 to 5 feet of water.

An examination of Manatee River, with a view to its improvement, was made in 1881. A report thereon, dated February 16, 1882, with plan of improvement, is printed as part of Appendix K 25, Annual Report of the Chief of Engineers for 1882.

PROJECT OF IMPROVEMENT.

The proposed improvement has for its object to form a channel, 100 feet wide and 13 feet deep at mean low water, from Tampa Bay to Shaw's and McNeill's points, a distance of about 4 miles. The available depth before improvement was 8 feet.

OPERATIONS UP TO JUNE 30, 1886.

Dredging was begun on this improvement March 26, 1883, and continued until April 14, 1883. It was again resumed February 18, 1884, and continued until April 25, 1884, when all work ceased. No further work has been done, owing to lack of funds.

During this time one cut was made 2,150 feet in length, 1,750 feet of which had a width of 60 feet and a depth of 12½ feet, and 400 feet had a width of 35 feet with same depth; 21,269 cubic yards of material were removed.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

In act approved August 5, 1886, Congress appropriated for "improving Manatee and Pease rivers, Florida: Continuing improvement, $13,000; of which $5,000 may be expended on Pease River."

As the wording of the appropriation left the amount to be expended on Pease River to the discretion of the Secretary of War, an examination of the two rivers named was made to determine, as far as possible—

(1) The improvements required for navigation.
(2) The cost of these improvements.
(3) The commercial interests involved.

After a careful examination of the subject it was found that the maximum amount which could be expended on Pease River ($5,000) was too small to be of any particular service, and that the expenditure of this sum on Pease River would leave so small an amount for Manatee River that nothing of any permanent value could be accomplished. It was, therefore, decided to reserve $2,000 for a survey and map of Pease River, and to expend the remaining $11,000 on improving the Manatee River.*

The examination of the river showed that the cut at the mouth made in 1883-'84 had held fairly well; that 8½ feet of water can be carried at all stages of the tide as far as Palmetto, and that, excepting for the bar between this point and Manatee, 6 feet can be carried as far as Rocky Bluff. A large portion of the freight carried on the river is for or from the towns of Manatee, Hendrix, and Ellenton, above this bar. The entire trade is dependent on water carriage. The nearest railroad is at Tampa, and the country roads are simply tracks through the sand.

When the project was adopted, the nearest railroad was at Cedar Keys, which was also the nearest port of lading for the regular Gulf steam-ship lines. It was accordingly a matter of great moment to permit sea-going vessels to enter the river. Since then Tampa has become the shipping point for railroad and steam-ships, and the wants of the small towns around Tampa Bay are supplied by light-draught steamers making regular trips from that port.

---

*For further details relating to Pease River, see the report for that stream.

A dredged channel, 100 feet wide and 13 feet deep, from Tampa Bay to McNeil's Point (Palma Sola) would cost $75,000, the increase of cost over the original estimate being due to the increase of actual over estimated prices. If small amounts are appropriated the estimate must be increased, since the cost of dredging under a small appropriation is proportionally much greater that under a large one, owing to the small competition and to the risks attending the towing of dredges from the distant ports where they are owned. During the past season not one bid for the work on this coast was made by dredging companies operating on the Atlantic coast. Further work in the 13-foot channel is not now recommended.

Under all of these considerations, commercial and engineering, it was determined to expend the amount available in dredging an 8-foot channel across the shoal between Palmetto and Manatee, so as to permit the passage of the regular coasting steamers at all stages of the tides.

Proposals for continuing the improvement by dredging according to this project were opened April 11, 1887, after the usual advertisement. Only one bid was received. It was rejected, as the plant which the bidder proposed to use was not satisfactory. As there was no prospect of obtaining satisfactory bids under readvertisement, authority was granted to have the work done in open market. Responsible contractors, having the requisite plant, were unwilling to bid on the works on this coast under the small appropriations available, since there could be no certainty of obtaining the contracts for all, and it would not pay to bring the plant so far for any one.

Under the authority thus granted a contract was entered into with Mr. Rittenhouse Moore, of Mobile, Ala., to do the work for 50 cents per cubic yard. This was approved by the Chief of Engineers May 31. Operations under the contract have not yet begun.

The amount available will be sufficient to make a cut from 40 to 60 feet wide across the bar near Manatee. From the nature of the material of which the bar is formed, and the direction of the tidal current at this point, a fair degree of permanence may be hoped for in the cut. It will be too narrow for easy navigation and should be widened to 90 feet, at an estimated cost of $15,000.

The existing charts of this river extend only as far as Rocky Bluff. They do not show the present condition of the channels accurately. To correct them and to survey the river as far as the head of light draught steam-boat navigation, an expenditure not to exceed $1,500 has been authorized. The appropriation asked for will be expended in accordance with the approved project.

For the commercial statistics of the Manatee River I am indebted to Mr. J. W. Harllee, of Manatee, and Mr. W. S. Warner, of Palma Sola.

Manatee is in the collection district of Key West, which is the nearest port of entry. **Nearest** light-house, Egmont Key Light. Nearest fort is Fort Jefferson, Fla.

Money statement.

Amount appropriated by act approved August 5, 1886, $13,000 for Manatee and Pease rivers, of which there was allotted to Manatee River		$11,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$589.92	
July 1, 1887, outstanding liabilities	19.60	
		609.52
July 1, 1887, amount available		10,390.48

Amount (estimated) required for completion of existing project	$75,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging Manatee River, Florida, opened April 11, 1887, *by Capt. W. M. Black, Corps of Engineers.*

No.	Name of bidder.	Price per cubic yard.	Remarks.
		Cents.	
1	S. M. Kimball	.50	Only bid.

Bid was rejected for reasons given in the report.

COMMERCIAL STATISTICS—MANATEE RIVER, FLORIDA.

[Furnished by Mr. J. W. Harllee, of Manatee, Fla., and Mr. W. S. Warner, of Palma Sola, Fla.]

Incoming freight.—Total tons, 3,171, consisting of lumber, fertilizers, and general merchandise; valued at $440,000.

Outgoing freight.—Total tons, 3,270, consisting of oranges and other fruits, winter vegetables, hides, wool, and skins; valued at $446,000.

The whole of the trade is dependent on water carriage. It would be increased to at least double the present amount were the improvement completed according to the existing project. During the past year there has been an increase of 50 per cent. in the total business.

NOTE (by Mr. J. W. Harllee).—"The work on the bulkhead across the river from a point between Manatee and Braidentown, on the south side of the river, and Palmetto and Hendrix on the north side of the river, if completed and a channel 60 feet wide and 9 feet deep, would increase the commerce of the river to at least five times the present amount at the Manatee, Hendrix, and Ellenton wharves. The channel across the bar at the mouth of the river 14 or 15 feet deep would increase the trade to double its present amount."

OFFICE OF J. W. HARLLEE,
Manatee, Fla., July 7, 1887.

DEAR SIR: Please find inclosed my report of commercial statistics for the Manatee River for the year ending June 30, 1887. Also statement made from records on forwarding and receiving books from four of the seven shipping stations on the river, and from the best information I could obtain from the three wharves from which I failed to get reports. I mailed circular letters to the agents at all the seven wharves on the river, begging them to make up from their books those statistics, giving them reasons for doing so. Four of those agents responded. Three of them have not yet responded, and I can not delay my report to you longer waiting their reports. The three wharves whose agents failed to report are Braidentown, Palmetto, and Union Wharf. I have made diligent inquiry and estimated the statistics from those three wharves as fairly as I can and think my report is about as nearly correct as could be gotten up.

I am well satisfied that I have not overestimated the commerce of this river, and that the report I make would fall short the full amount of commerce of the river instead of exceeding it.

I trust that the work on the bulkhead reaching across from Manatee to Palmetto will be completed at an early day.

This is the work you had surveyed last, and would add very much more to the commerce of the river than any other work at present.

You will see on my report the amount of imports and exports at the three wharves above this bulkhead, viz: Manatee, Hendrix, and Ellenton. A channel through this bulkhead would be of very great benefit to those three stations, as above this bulkhead the channel is from 15 to 20 feet deep for 3 or 4 miles up the river.

Trusting that the report I send you will prove satisfactory,

I am, very truly, your obedient servant,

J. W. HARLLEE.

Capt. W. M. BLACK,
Corps of Engineers.

Commercial statistics for Manatee River, Florida, for the fiscal year ending June 30, 1887, *showing distribution of shipments among the various landings.*

Landings.	Express packages.	Freight packages.	Freight and express packages.	Estimated weight.	Valuation.
Manatee Wharf (actual figures taken from forwarding and receiving books):	*No.*	*No.*	*No.*	*Lbs.*	
Packages imported	277	34,209	34,486	2,410,855	$168,759.85
Packages exported	4,667	24,734	29,401	2,441,360	170,895.20
Hendrix Wharf (actual figures from record; nothing imported to this wharf):					
Packages imported					
Packages exported	683	7,862	8,545	445,250	31,167.50
Ellenton Wharf (report by Mr. George T. Patten, agent; actual figures from record):					
Packages imported	(*)	(*)	(*)	74,000	2,800.00
Packages exported	(*)	(*)	(*)	320,000	12,000.00
Palma Sola Wharf (report by Mr. W. S. Warner, agent; actual figures from record):					
Packages imported		2,220	2,220	174,220	12,195.40
Packages exported	2,173	3,634	5,807	580,354	40,624.78
Braidentown Wharf (estimated from best information, agent failing to send in report):					
Packages imported		11,495	11,495	803,285	56,253.25
Packages exported		6,000	6,000	480,000	33,600.00
Palmetto Wharf (estimated from best information, agent failing to send in report):					
Packages imported		17,243	17,243	1,205,427	84,379.92
Packages exported		12,000	12,000	960,000	67,200.00
Union Wharf (estimated from best information, agent failing to report):					
Packages imported		8,621	8,621	601,809	42,189.96
Packages exported		3,000	3,000	240,000	16,800.00
Total footings	7,800	131,018	138,818	10,736,560	738.865.86
Totals down				10,736,560	738,865.86
Total imports and exports by sailing vessels				2,147,312	147,773.17
				12,883,872	886,639.03

* Not given.

O 8.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

Tampa Bay is a large indentation in the Gulf coast of Florida, with an average width of from 6 to 7 miles, and a length, including Hillsborough and Old Tampa bays, into which its inner end is divided, of 35 miles. Across the bar and up to the point of division, a distance of 25 miles, the channel has a depth of from 20 to 38 feet.

Old Tampa Bay, the northwestern division, is about 10 miles long, with an average width of 5½ miles. Near its mouth there is a channel depth of over 20 feet of water. A depth of 10 to 12 feet extends to its head. Hillsborough Bay has an average width of 5 miles, with depth varying from 16 feet at the mouth to 8 feet near head. Flats, with low-water depth from 1 foot to 5 feet, varying in width from ¼ to 1 mile, surround the entire body of water.

Its principal tributary is the Manatee River. The principal town is Tampa, lying at the mouth of the Hillsborough River, at the head of Hillsborough Bay, but separated from the deep water of the bay by a broad flat, through which runs a narrow channel formed by the waters of Hillsborough River. Through this, before improvement, vessels drawing 8 feet of water were able to reach Tampa only by taking advantage of high tides.

Tampa is the terminus of the South Florida Railroad, which there forms connection with the steamship lines for Key West, Havana, and New Orleans, and the Florida coast ports. The South Florida Railroad gives by its present connections a through line to the north, east, and west from Sanford, the eastern terminus. Other railroads are projected to Tampa.

An examination of Tampa Bay, with a view to its improvement, was made in 1879. A report thereon, dated August 25, 1879, with a plan of improvement, is printed as Appendix J 18 to the Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening and widening the channel from Tampa to the bay, a distance of 5¾ miles, by dredging and rock excavation, so as to give a clear depth of 9 feet at mean low water, and a width in the river of 200 feet and in the bay of 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1886.

Work was done by contract under the following appropriations:

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	20,000
By act approved July 5, 1884	20,000
Total	60,000

The work consisted entirely of dredging and rock excavation, and extended over a length of 8,215 feet, with a width varying from 60 feet in the bar to 150 feet in the river. This channel has been filled somewhat by the tidal currents, and on June 30, 1887, it had a depth along the center line of from 8.3 to 9 feet, with a width of about 60 feet.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

In act approved August 5, 1886, $10,000 were appropriated for continuing the improvement. Proposals for dredging and rock excavation were opened February 5, 1887, after advertisement in the usual manner. Only two bids were received. They were too high and both were rejected. The work was readvertised, and new proposals were opened April 11. Only one bid for the entire work was received. It was again too high, and again rejected.

It was evident that no competition could be obtained for this work by advertising in the usual manner. Dredging operations were required for three works on the west coast of Florida, lying near together, viz: Cedar Keys, Tampa, and Manatee River. Proposals for all were asked at the same time, but as under the Revised Statutes (sect 3717) separate proposals had to be asked for each work, there was no certainty that the same contractors could obtain all three. Consequently few responsible contractors with good plant were willing to bid at all, as there was hardly enough money for any one of the works to warrant the risk to be run in towing the dredging plant the necessary distance from where it was owned.

Authority was therefore obtained to have the work done by contract made in open market. Accordingly a contract was entered into with Mr. Rittenhouse Moore, of Mobile, Ala., approved by the Chief of Engineers May 31, for excavating rock for $5.90 per cubic yard, and for dredging soft material for 44 cents per cubic yard. Operations under the contract commenced June 29. The work will consist of cutting the channel to the full width of 200 feet through the mud and rock at the mouth of the river.

It will probably be completed before September 1.

Current observations made in June show that, as was reported in the last annual report, dredging operations in the bay unassisted by deflecting works will not be permanent.

The tidal currents in the bay are oblique to the line of the channel, as shown in the accompanying diagram. In the annual report for 1886, the estimate for completing the existing project by dredging was $73,000, and this estimate must be increased for the increased cost of small amounts of dredging under the appropriations available. The least estimate for the deflecting dike was $50,000. Inasmuch as the channel then gained will have a very limited depth and width, it would seem better to appropriate annually a sum represented by the interest on the total sum required, with which the present channel could be kept clear for the use of light-draught vessels, and in addition to improve the entrance to Old Tampa Bay, so as to make that the deep-draught harbor for the city of Tampa.

For a comparatively small sum this entrance can be improved to admit vessels of 20 feet draught, and such vessels lying at the wharves near Little Mangrove Point would be but little further from Tampa than the present anchorage for vessels of 10 feet draught. The South Florida Railroad is even now running its tracks to this point with the design of making it the terminus for the Key West and Havana Steamship line, the vessels of which are now served by lighters from Tampa.

As is seen by the commercial statistics, for which I am indebted to Mr. T. K. Spencer, deputy collector for Tampa, the city is growing rapidly in importance as a shipping point, and better facilities for the existing commerce are greatly needed.

The amount on hand and the appropriation asked for will be used in accordance with the project.

A map of the harbor and a report on the current observations, made by Mr. J. W. Sackett, assistant engineer, are inclosed.

Tampa Bay is in the collection district of Key West, which is the nearest port of entry. Nearest light-house, Egmont Key Light, Nearest fort is Fort Jefferson, Fla.

Money statement.

July 1, 1886, amount available		$830.46
Amount appropriated by act approved August 5, 1886		10,000.00
		10,830.46
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$771.63	
July 1, 1887, outstanding liabilities	426.65	
		1,198.28
July 1, 1887, amount available		9,632.18

Amount (estimated) required for completion of existing project	$63,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	63,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving harbor at Tampa Bay, Florida, opened February 5, 1887, *by First Lieut. W. M. Black, Corps of Engineers.*

No.	Names of bidders.	Price per cubic yard.		Remarks.
		Dredging.	Rock excavation.	
1	Rittenhouse Moore	$ .59	$7.49	
2	S. N. Kimball	.45	6.95	Lowest bidder.

Bids were rejected for reasons given in the report.

Abstract of proposals for improving harbor at Tampa Bay, Florida, opened April 11, 1887, *by Capt. W. M. Black, Corps of Engineers.*

No.	Names of bidders.	Price per cubic yard.		Remarks.
		Dredging.	Rock excavation.	
1	John Maguire	....	$5.90	Does not propose to do any dredging.
2	S. N. Kimball	$ .44	6.90	

Bids were rejected for reasons given in the report.

REPORT OF MR. J. W. SACKETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., June 30, 1887.

CAPTAIN: In pursuance with the instructions contained in your letter of June 7, in regard to current observations at Tampa, on June 23 and 27, I obtained sufficient data to construct complete diagrams of the directions and velocities of the currents through both ebb and flood tides.

The station was situated in the channel below Spanish Town Point.

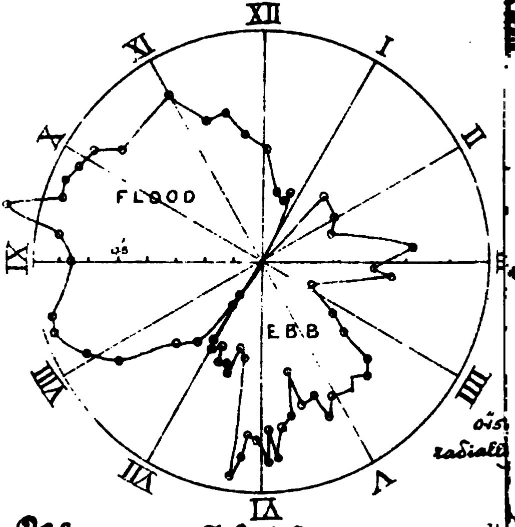
The method devised and pursued was as follows:

Parallel ranges, 100 feet apart and forming an angle of 90 degrees with the axis of the channel at that point, were erected. A boat was fastened to a stake in the channel on each range. The boat on the upper range, if on the ebb tide, the lower, if on the flood, contained an observer with a sextant. The float was started so that it would cross the line near the boat. At the instant it crossed the second range the angle which its direction made with the range was measured. The time was noted at the instant the float crossed each range. In this way the length of the path traversed and the direction taken by the float could easily be determined.

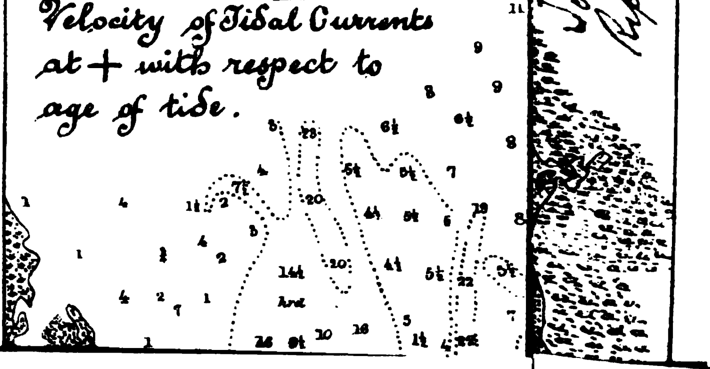
A portion of a cargo of cocoa-nuts, intended for planting, being found in such a condition that it was judged that they would not germinate, were thrown away. A number of these were secured for floats. It was found by experiment that they would naturally float with the "eyes" down. A piece of wood about 2 inches long and three-eighths of an inch in diameter was fastened to each end of a cord of a length equal to half the depth of the water. The cocoa-nuts being selected in pairs, one large and one small, they were joined by shoving the sticks at the ends of the cord entirely into the cocoa-nuts through the soft "eye." The cocoa-nut when full of water will readily

Head of Tampa Ba

Plate I.



Velocity of Tidal Currents at + with respect to age of tide.



To accompany Annual Report for 1887. H. M. Black Capt. & Eng.

sink, so the large one filled with water would remain at mid depth sustained by the empty small one, which being with the "eye" down would not admit enough water to sink it and would float at the surface.

The results of these observations are shown in the accompanying diagrams. Plate 1 shows the velocity with respect to time. Plate 2 shows the velocity and the corresponding direction. For simplification the tides were divided into ten stages of equal duration, and only the mean direction and velocity for each stage is shown in Plate 2.

An examination of Plate 2 shows that the flood tide is comparatively decided in direction, beginning at N. 30° E. and ending at N. 50° E., with a mean direction of N. 37° E., evidently following the trend of the contours of the west and north side of the bay, and crossing the channel from west to east at an angle of 26°.

The ebb tide is divided into two distinct parts with entirely different directions. The first four stages, or four tenths, flow in a mean direction of S. 31° E., crossing the channel from west to east at an angle of 43°. At the fifth stage of the tide, the surface of the water being lower the water is confined more to the channel, the direction suddenly changes to S. 33° W. and remains at a mean of S. 32° W. during the rest of the tide, not varying more than 2°, and crossing the channel from east to west at an angle of 20°.

The maximum velocity observed during the ebb tide was 0.732 feet per second and during the flood tide 0.910 feet per second.

Very respectfully, your obedient servant,

J. W. SACKETT,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS PORT OF TAMPA, FLORIDA.

[Furnished by T. K. Spencer, deputy collector of customs.]

Imports by water in fiscal year ending June 30, 1887: Total tons, 108,696, consisting of 147 steamers, bringing 3,200 bales leaf tobacco and 1,604 pipes claret wine, valued at $381,936.

The entire foreign trade depends on water carriage, and has been increased about 1,000 per cent. foreign (and considerable local) in the fiscal year ending June 30, 1887.

Referring to imports, would state that the 3,200 bales of tobacco and 1,604 pipes of wine, valued at $381,936, used at this port, would have paid a duty at this port of $130,216.32 if it had been imported under the immediate transportation act. There have been no exports from this port, as the matter stands as heretofore, this port doing no business save as a port of delivery to the district of Key West.

Class, tonnage, etc.	Arrived.				Cleared—coastwise.	
	Coastwise.		Foreign.			
	June 30, 1885, to June 30, 1886.	June 30, 1886, to June 30, 1887.	June 30, 1885, to June 30, 1886.	June 30, 1886, to June 30, 1887.	June 30, 1885, to June 30, 1886.	June 30, 1886, to June 30, 1887.
Steamers ....tons..	39, 840	114, 357	25, 480	108, 696	39, 830	136, 835
Sailing vessels ....do...	5, 220	6, 101	....	....	5, 220	6, 101
Total tonnage....	45, 060	120, 458	25, 480	108, 696	45, 050	142, 936
Total passengers.	917	1, 750	1, 173	2, 003	1, 230	3, 730
Duties collected:						
On articles of small value in passengers' baggage....					$2, 181. 41	$3, 954. 61
On articles under immediate transportation....					....	8, 586. 62

O 9.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on in accordance with the project submitted to the Chief of Engineers by the officer then in charge, in 1879 and published as part of Appendix K 18 to the Annual Report of the Chief of Engineers for 1880.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and by deepening some of the worst shoals and a bar at the mouth of the river, so as to enable boats drawing 2 feet to navigate the river during about half the year from the mouth to Hay's Ferry, a distance of 100 miles.

The original depth of the river was from 1 to 7½ feet, with a width of from 75 to 150 feet.

In accordance with the recommendations contained in the Annual Report for 1885, the improvements have been extended as far as Pemberton Ferry, 6 miles above Hay's Ferry.

OPERATIONS PRIOR TO JUNE 30, 1886.

Work was carried on by hired labor under the following appropriations:

By act of Congress, approved March 3, 1881	$7,500
By act of Congress, approved July 5, 1884	3,000

The work was done between the mouth and Hay's Ferry, and a channel, navigable at all except the lowest stages for boats drawing 2 feet of water, was opened excepting in the vicinity of Morrison's Shoals. Regular steamboat navigation was established on the river over a stretch of 26 miles, from the railroad at Panasoffkee to Cotton's Grove on the north and Istachatta on the south.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

By act of August 5, 1886, $3,000 were appropriated for continuing the improvement of the river. After examination it was decided to open the river from Pemberton Ferry to Hay's Ferry, and as much further as the funds available would admit, so as to enable shippers to reach the Florida Southern Railroad at the first-mentioned point, and secure the benefits of competition between the two roads touching the upper river.

It was decided to do the greater portion of the work by contract. To this end sealed proposals were opened on February 5, 1887, after due advertisement.

The contract was awarded to Mr. S. C. Barker, of Windsor, Fla., the lowest bidder, for $1,850. Work under this contract was commenced in March and finished May 9, 1887. The work consisted in removing snags and logs from the river, in building log and brush dams across bayous, and in clearing away overhanging trees and brush. This work opened a channel for boats of 2 feet draught and 20 feet beam between Pemberton and Hay's Ferry for all excepting the lowest stages of water in the river.

The work thus done made a permanent lowering of the water surface at and near Pemberton Ferry. Rocks and other obstacles, before hidden, appeared. It was decided to organize a party and with the remainder of the appropriation continue the work from Pemberton Ferry down. Operations were begun May 26 and continued until June 12.

All of the worst obstructions were removed between Panasoffkee Lake and Pemberton Ferry. Excepting at a wide point above Hay's Ferry the river was opened for navigation throughout the year. Here the navigation is possible excepting at the exceptionally low stages which prevailed when work ceased.

At many points in this reach the channel is narrow and tortuous and more work can be done to advantage.

This work has been done under the local charge of Capt. O. J. Parker, of Cedar Keys, Fla.

The Withlacoochee River from Hayes's Ferry to the western line of section 19, township 17 south, range 20 east, below Morrison's Shoals, traverses a series of open lakes and wooded lagoons, generally shallow and of varying widths. The lakes are interspersed with floating masses of wild lettuce, bonnets, and careless weeds, and with numerous islands covered with tillers and aquatic plants. The wooded lagoons are heavily timbered, and traversed by one or more narrow and crooked channels, which, however, afford 2 to 4 feet of water at the ordinary low stage, though in many places not more than 30 feet in width. The current flowing in the lake channels is sluggish while that in the lagoon channels generally flows swiftly.

From the western line of section 19 (above mentioned) to the mouth the river, for the most part, confines itself to a single channel, the width is more uniform, the current rapid, and the bed generally covered with loose rocks at the places of shoals and shallows. The channels between these rocks are narrow, crooked, and impassable at very low water. These places are miscalled shoals in many cases, since the depth of water between the rocks is as great as is elsewhere obtained. Here the river can be rendered navigable by breaking up and removing the soft limestone rocks, which are generally much less than a cubic yard in size.

Just above the mouth the river is divided by Chambers' Island into two branches, flowing northwest and southwest, respectively. The north branch affords quite as good water as the other, and has the better approach from the Gulf of Mexico. This approach is a narrow channel (from 1¼ to 3¼ feet deep at mean low water), which crosses a shallow bar, composed chiefly of oyster beds, and lying off the mouth of the river. (Rep. of Chief of Engineers, 1880, Pt. II, p. 1118.)

The country along the banks consists mainly of high rolling hammock land, surrounded by cypress swamps. It is excellently adapted to raising fruits and vegetables, and is fast filling up. At this date no steamers navigate the lower river regularly. One is nearly completed at Blue Springs and will be used for this purpose.

The Silver Springs, Ocala and Gulf Railroad Company are now operating their road to Blue Springs, which is on the Wekiva River, a tributary of the lower Withlachoochee. Their right of way is cleared to the river, which they expect to cross during the coming year.

Two small steamers make regular trips on the upper river. About 3,000 tons of freight were carried on them during the past year, principally consisting of oranges, early vegetables, and general merchandise. The amount is increasing yearly as transportation facilities increase. Since work on the river began, the freight charges have been decreased from 25 to 50 per cent. Should the river be made easily navigable through its entire length the annual shipment of oranges alone would soon amount to 100,000 boxes.

An examination of the river shows that to make it navigable throughout the year from Pemberton Ferry to the Gulf of Mexico, for boats drawing 2 feet of water, would require an expenditure of $33,000. This would include dredging across the bar at the mouth of the river.

The increase of cost over the original estimate is due to the change in the project of preparing for navigation throughout the year instead of during half the year, a change which the size and importance of the stream will amply warrant. If the improvement were completed, an annual expenditure of $800 would suffice to maintain the works.

All of the work can be done most economically by the use of a stern-wheel steamer fitted for snagging, dredging, and pile-driving and owned and used by the United States in the rivers of the west coast of Florida now under improvement. The cost of such a boat would not exceed $10,000. The amount of the last annual appropriation for these streams did not warrant its purchase.

The balance on hand will be used in the care of the public property. The appropriation asked for will be used in accordance with the project.

I am indebted to Capt. S. R. Pyles, of Panasoffkee, for the appended commercial statistics.

Withlacoochee River is in the collection district of Cedar Keys, Fla., which is the nearest port of entry. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1886, amount available		$156.80
Amount appropriated by act approved August 5, 1886		3,000.00
		3,156.80
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,660.87	
July 1, 1887, outstanding liabilities	357.16	
		3,018.03
July 1, 1887, amount available		138.77
Amount (estimated) required for completion of existing project		10,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for improving Withlacoochee River, Florida, opened February 5, 1887, by First Lieut. W. M. Black, Corps of Engineers.

No.	Names of bidders.	Amount.	Remarks.
1	S. C. Barker	$1,850.00	Lowest bid.
2	F. W. Boyer	2,440.50	
3	Frank Weller	5,750.00	

Contract awarded to S. C. Barker, with the approval of the Chief of Engineers.

COMMERCIAL STATISTICS—UPPER WITHLACOOCHEE RIVER, FLORIDA.

[Furnished by Capt. S. R. Pyles.]

Imported.—Total tons, 1,065, consisting of general merchandise.

Exported.—Total tons, 1,605, consisting of oranges, tomatoes, egg plants, potatoes, cucumbers, cabbage, cotton, etc.

Value, $87,768.

The total trade of this locality is dependent on water carriage. It would be more than doubled in one year were the improvements completed.

During the last year there has been an increase of about 50 per cent. in the total business. These statistics are based on the actual amounts of freight carried by the steamer *Sam Pyles* and the estimated amounts carried by steamer *May Bell.*

O 10.

IMPROVEMENT OF HARBOR AT CEDAR KEYS, FLORIDA.

An improvement was made of this harbor in 1872–1881, as follows:

A cut 200 feet wide and 11¼ feet deep down to the limestone through the middle ground; another 200 feet wide and 12 feet deep through the outer bar, excepting at a point 80 feet from the line of black buoys, where the limestone is 11¼ feet under the surface, the remaining 120 feet on the east side of the cut being fully 12 feet deep.

The harbor of Cedar Keys lies on the Gulf side of the peninsula of Florida. It is the terminus of the Central Division Florida Railway and Navigation Company. For years this was the only line of railroad between the Gulf and the Atlantic south of Pensacola, in Florida. The principal business done at Cedar Keys is in lumber, and it forms a distributing point to a large area to the north and south of it.

An examination with a view to its improvement was made in November, 1883. A report thereon, together with a plan of improvement, was printed as Appendix N 30 to the Report of the Chief of Engineers for 1884.

PROJECT OF IMPROVEMENT.

The approved project as there described is as follows: To obtain a channel 200 feet wide and with a least depth of 10½ feet from Cedar Keys to the Gulf of Mexico. A depth of 9½ feet formerly existed in this channel. The depth is limited by the existence of beds of rock under the entire channel from 9½ to 12½ feet below mean low water, which could only be removed at greater expense than the present and prospective commerce of the port would seem to warrant.

On this project an appropriation of $5,000 was made by act approved July 5, 1884.

Under this appropriation a cut was started through the rock near buoy No. 12, on October 14, 1885, and continued until the exhaustion of the appropriation. Three hundred and seventy cubic yards of sand and 615.3 cubic yards of rock were removed. To complete the channel at this point to a width of 200 feet and the desired depth would require the removal of 7,800 yards more, of which one-fourth is rock. The dredged cut at this point has remained clear.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1887.

In act approved August 5, 1886, $7,000 were appropriated for this work. The shoaling of the cut made through the middle ground in 1872–1881 had made it difficult for vessels to approach the railroad wharf. The location of this cut is faulty, and current observations show that without the aid of auxiliary works there is no hope of permanency for it. Still, with the small amount available, nothing could be done excepting to reopen the cut, giving it a direction as nearly as possible in line with the flood currents, through the main ship-channel.

Proposals for doing this work were opened February 5, after due advertisement. Two bids were received. As the prices bid were deemed excessive both were rejected. The work was readvertised, and proposals were opened April 11. Only one bid was received. It was rejected, as the bidder proposed to use plant which was inadequate for the work.

As there was no hope of obtaining further bids by readvertisement, authority was obtained to make a contract for the work in open market.

Accordingly a contract was made with Mr. Rittenhouse Moore, of Mobile, Ala., for dredging the cut, at a rate of 45 cents per cubic yard. This was approved by the Chief of Engineers' May 31, 1887. The same difficulty has been experienced in this harbor as in Manatee River and the harbor of Tampa, in making satisfactory contracts for the work under the small appropriation available.

A revision shows that the estimate made in 1883, of the amount of dredging required to complete the project, is too small. As near as can be determined from the existing maps, 43,000 cubic yards of silt and 4,500 cubic yards of rock must yet be removed from the channel through the middle ground, near buoy No. 12 and near buoys Nos. 9 and 10, at an estimated cost of $54,000. To insure permanency in the cut through the middle ground, a dike would be required, which would cost $15,000. Its immediate construction is not recommended.

The amount on hand and the appropriation asked for will be used in accordance with the project.

Cedar Keys is in the collection district of Saint Mark's, of which Cedar Keys is the headquarters. Nearest light-house, Cedar Keys Light. Nearest fort is Fort Marion.

Money statement.

Amount appropriated by act approved August 5, 1886		$7,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$269.59	
July 1, 1887, outstanding liabilities	12.60	
		282.19
July 1, 1887, amount available		6,717.81
Amount (estimated) required for completion of existing project		54,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging in harbor at Cedar Keys, Fla., opened February 5, 1887, by First Lieut. W. M. Black, Corps of Engineers.

No.	Names of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	S. N. Kimball	47¼	Lowest bidder.
2	Rittenhouse Moore	59	

Bids were rejected for reasons given in the report.

Abstract of proposals for dredging in harbor at Cedar Keys, Fla., opened April 11, 1887, by Capt. W. M. Black, Corps of Engineers.

No.	Name of bidder.	Price per cubic yard.
		Cents.
1	S. N. Kimball	47¼

Bid was rejected for reasons stated in the report.

COMMERCIAL STATISTICS—PORT OF CEDAR KEYS, FLORIDA.

[Furnished by Mr. F. E. Hale, President Board of Trade, Cedar Keys, Fla.]

Class, tonnage, etc.	ARRIVED.		CLEARED.	
	Coastwise.	Foreign.	Coastwise.	Foreign.
	June 30, 1886, to June 30, 1887.	June 30, 1886, to June 30, 1887.	June 30, 1886, to June 30, 1887.	June 30, 1886, to June 30, 1887.
Steamers	166	....	166	....
Sailing vessels	1,712	4	1,714	1
Total tonnage	48,158	1,107	49,680	306
Total crews	7,594	25	7,782	7
Total passengers	1,040	....	1,940	....

Value of imports by rail	$366,800
Value of exports by rail	328,905
Value of imports by water	1,111,770
Value of exports by water	420,500

The imports and exports consist of general merchandise, fruit, vegetables, and lumber.

O 11.

IMPROVEMENT OF SUWANEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on since November, 1881, under appropriations made in 1880, 1881, 1882, 1884, and 1886, aggregating $23,000.

The Suwanee River rises in the southern part of Georgia, near the Okefinokee Swamp, and flowing in a general southerly direction, empties into the Gulf of Mexico a few miles north of Cedar Keys. The portion examined with a view to its improvement extends from Ellaville to its mouth. The country adjacent is well wooded, and the chief trade is in pine, cypress, and cedar timber, cotton, sirup, the minor farm products, and naval stores.

An examination of this river with a view to its improvement was made in 1879. A report thereon, dated August 26, 1879, with a plan of improvement, is printed as Appendix J 16, Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the bar at the passes by dredging, the removal of snags and overhanging trees along the river, and deepening and improving the channel at various places by the removal of rocks, snags, and construction of dams, so as to strengthen, widen, and deepen the channel. The depth to be obtained is 5 feet through the bars at the passes for a width of 150 feet, and up the river as far as Roland's Bluff, a distance of 74 miles. From there up to Ellaville, a distance of 50 miles, the depth is to be 4 feet and the width 60 feet.

OPERATIONS PRIOR TO JUNE 30, 1886.

Work was done by contract under the following appropriations:

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
Total	$18,000

It consisted entirely of dredging operations across the Suwanee Basin at the east pass. On this line the distance from deep water of the Gulf to deep water in the river is 15,600 feet. A cut 5,835 feet long, 60 feet wide, and 5 feet deep at mean low water was made, leaving a length of 9,765 feet to be dredged, through water having an average depth of 3½ feet.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

By act approved August 5, 1886, $5,000 were appropriated for continuing this improvement. An examination was made of the river in the neighborhood of New Branford (Roland's Bluff) and of the Suwanee Basin at the east pass. The cut in the basin was found to have held its depth very well excepting at its outer end, where some shoaling was observed.

An examination of the commercial interests showed that excepting cedar timber the movement of freight was almost entirely between the railroad at New Branford and the various towns on the river. Quite a large amount of cedar timber is consumed by the pencil factories whose agencies are at Cedar Keys, and a large part of the supply is obtained in the Suwanee River and its vicinity. This is practically the only export which passes out of the mouth of the river. The cedar is in rafts towed by light-draught steamers, which remain as far as possible within the shelter of the keys along the coast. In going to Cedar Keys the usual route is through the Suwanee Basin to an entrance in the south called Derrick Island Gap. This route is the more direct and is sheltered and safe. The gap or pass is badly obstructed with oyster bars, and a request was made that a portion of the funds appropriated for the improvement of the Suwanee River be expended here. This was not considered possible under the wording of the appropriation.

Boats using this route to Cedar Keys do not need any extension of the present dredged channel at the east pass. The upper river was found to be badly obstructed by rocks and logs. Navigation above New Branford was only possible during the highest stages of the river. As the railroads touch the river only at New Branford and Ellaville, the development of the intermediate country has been greatly retarded by the lack of means of communication. The roads are bad and the bulky products of the country, cotton, corn, and naval stores, could not be marketed to advantage. The land is excellent in quality and the region is healthy.

Under these considerations it was deemed best to expend the appropriation in clearing the river above New Branford by hired labor. The snag-boat was repaired and towed to New Branford with a party under the charge of Capt. O. J. Parker, of Cedar Keys. The party arrived at Double Island Shoals, 10.64 miles above New Branford, on February 15, and immediately commenced operations. These were carried on between New Branford and Luraville, a distance of 20.61 miles. Forty-five overhanging trees were cut and 32 trimmed on the banks; 32 snags, 24 logs, and 370.5 cubic yards of rock were removed from the channel. The trees were generally live-oaks and water oaks. The rock was a compact hard limestone containing layers and nodules of flint. It was in bowlders and ledges, and had to be blasted from crevices and from the surface, as the flint layers made drilling generally impracticable. The explosive used was rack-a-rock, fired by electric fuses and a No. 3 Rand magneto machine. When fired in cases of tin or glass the work of the explosive was satisfactory.

At the end of March the high stage of water made further work disadvantageous and operations were suspended until the river should fall.

RESULTS.

The work done cleared the channel for 4-foot navigation at all stages of the water for a distance of 10 miles below Luraville, as far as Strip Jacket Shoals. There and below enough rock was removed from the river to permit the passage of steamers drawing 4 feet of water at all excepting the lowest stages, or of boats drawing 2 feet of water and with the ordinary beam, throughout the year. As a result of these operations a stock company was formed for building a light-draught steamer for regular traffic in the river, and a greatly increased acreage was planted with cotton.

FUTURE OPERATIONS.

An examination of the entire river shows that $15,000 will be required to complete the existing project, excluding the extension of the channel across the bars at the passes, which would cost $35,000 in addition; the increase in this estimate arising from the excess of the actual over the estimated cost of dredging. This extension is not recommended. Should it be decided to improve further one of the entrances into the river, that through Derrick Island Gap is the one which would be most useful to commerce under its present conditions. The oyster bars which obstruct this pass are rapidly growing and will soon completely close it. Five thousand dollars would be required to clear this entrance. After the improvement has been completed the river can be kept clear by an annual expenditure of $800.

Work in this river could have been done much more economically and expeditiously had the United States had a suitable steam snag-boat on the west coast of Florida. The boat on hand is old, has no steam power, and is of little value excepting as a quarter-boat. The five rivers on this coast on which work is being carried on, the Suwanee, Withlacoochee, Manatee, Pease, and Caloosahatchee, have an aggregate length under improvement of 375 miles. All of the work in them excepting the heavier dredging operations near the mouths of the Manatee, Pease, and Caloosahatchee rivers could easily be done with one boat at a minimum expense to the United States. The cost of a suitable stern-wheel boat, equipped as a snag-boat, with dredging and pile-driving machinery, would be about $10,000. On account of the limited amounts available for these rivers during the past year it has been necessary to use the plant on hand at a greatly increased cost to the United States.

One source of obstruction to this river results from the carelessness of the lumbermen. Logs are cut into the river and floated to the mills without rafting them. Large numbers of these logs stick in the shoals and form dangerous obstructions. The stream is also injured by sawdust, slabs, and edging dumped into the river from the mills or placed where they are floated into it by high water. There seems to be no adequate means of protection afforded the United States against this misuse of the river.

The completed improvement of the Suwanee River above New Branford would be immediately followed by a great development of the country. During the past season 400 bales of long-staple cotton passed through Luraville alone. The opening of the river to Ellaville and through Derrick Island Gap to Cedar Keys would give access to another railroad and to the Gulf commerce, lowering the rates of freight and increasing the production of the staples, corn, cotton, and naval stores, fruits, and vegetables. For the actual amount of commerce in the river I would invite attention to the appended letter from Messrs. McIntosh & Ivey, of New Branford, to whom, as the most prominent residents and merchants of the region, application was made for the information.

The amount on hand will be expended in continuing the work in the upper river in accordance with the specifications. The appropriation asked for would be expended in accordance with the approved project.

Suwanee River is in the collection district of Cedar Keys, Fla., and Cedar Keys is the nearest port of entry. Nearest light-house is Cedar Keys light. Nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1886, amount available		$60.00
Amount appropriated by act approved August 5, 1886		5,000.00
		5,060.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,694.07	
July 1, 1887, outstanding liabilities	356.05	
		3,050.12
July 1, 1887, amount available		2,009.88
Amount (estimated) required for completion of existing project		32,158.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS—SUWANEE RIVER, FLORIDA.

[Furnished by Messrs. McIntosh & Ivey Bros., New Branford, Fla.]

Incoming freight.—Total tons, 15,576, consisting of general merchandise, lumber, timber rafts, crude naval stores, fertilizers, brick, machinery, etc., valued at $244,000.

Outgoing freight.—Total tons, 600, consisting of general merchandise, lumber, cotton, manufactures, naval stores, live stock, and country produce, valued at $275,000.

Three-fourths of the total trade is dependent on water carriage. It would be increased 50 per cent. were the improvement completed. During the past year there has been an increase of 60 per cent. in the total business.

The tonnage was taken from actual weights on railroad books.

O 12.

REMOVAL OF SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of the wreck of the steamer Dictator.—This was a wooden side-wheel steamer, of 512 tons, built at Brooklyn, N. Y., 1863. It was burned to the water's edge in the harbor of Tampa, December 26, 1883, and the hull and machinery lay near Spanish Town Point, in the edge of the main ship-channel.

It having been reported as an obstruction to navigation, the honorable Secretary of War directed that the proper steps should be taken for its removal. Due notice to the owners, in accordance with law, was published in February, 1885.

On November 12, 1885, proposals for the removal of the wreck were opened. Messrs. William H. Brown and George Theodore, of New Orleans, La., were the lowest bidders, and the contract was awarded to them for $2,500.

The agreement states—

> Work of removal is to be commenced on or before December 11, 1885, and is to be completed on or before February 1, 1886.

After numerous delays, operations under the contract began January 13, 1886. Work progressed very slowly, and there were numerous disagreements between the contractors. On February 25 the contractors finally disagreed, and one of them abandoned the work.

On April 8, 1886, authority was given by the Chief of Engineers, United States Army, to annul the contract, the time for its completion having expired.

The work was readvertised and proposals opened June 17. Messrs. Charles H. Schenck and Nicholas Theodore, the lowest bidders, were awarded the contract for $2,500. This contract was approved July 22, 1886. Operations under it were begun on August 9 and continued until all of the wreckage had been removed.

After due advertisement the wreckage was sold to the highest bidder at public auction on November 11 for $160, and the amount duly deposited in the United States Treasury.

O 13.

PRELIMINARY EXAMINATION OF TAMPA BAY, FLORIDA, INCLUDING HILLSBOROUGH RIVER UP TO THE CITY OF TAMPA.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz:

* * * * * * *

RESURVEY OF TAMPA BAY, INCLUDING HILLSBOROUGH RIVER UP TO CITY OF TAMPA.

* * * * * * *

An examination of this harbor showed that the existing Coast Survey charts are sufficiently accurate for all needed purposes. In a personal interview with the members of the Board of Trade of the City of Tampa, it was stated that what was desired was a plan of improvement which would give reasonable promise of permanency and would afford a channel from 14 to 16 feet at mean low water.

Plans were submitted to the Chief of Engineers in the Annual Report on this improvement, dated June 30, 1886, which it is believed will give a permanent 9-foot channel. Once this has been obtained it will be easy to enlarge it to a greater depth if it then be thought desirable.

So far the appropriations have never been sufficient to obtain the 9-foot channel called for by the approved project.

Owing to the greatly increased cost of a deeper channel I believe that the interests of commerce do not now demand more than a permanent channel of the dimensions called for by the existing project.

Respectfully submitted.

W. M. BLACK,
First Lieutenant of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 14.

PRELIMINARY EXAMINATION OF CHARLOTTE HARBOR, INCLUDING SAN CARLOS BAY, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz:

* * * * * * *

CHARLOTTE HARBOR, INCLUDING SAN CARLOS BAY.

* * * * * * *

Examinations were made of Charlotte Harbor in 1879 by Mr. J. L. Meigs, assistant engineer, under the direction of Maj. A. N. Damrill, Corps of Engineers, and in 1884 by Capt. William T. Rossell, Corps of Engineers, as published in the Annual Reports of the Chief of Engineers for 1880 and 1885, in Appendix K 17 and Appendix O 20, respectively.

Charlotte Harbor and San Carlos Bay afford the most southerly good harbor on the west coast of Florida. Land in the vicinity is fast being settled and the importance of the bay is increasing daily. As yet there is but little commerce, very little produce being raised, and the principal imports being building materials. It has not been possible to obtain exact figures. A small steamer makes three trips per week between the railroad at Cleaveland, Punta Rassa, and Fort Myers, on the Caloosahatchie River, touching at intermediate points, and amply satisfies existing needs.

On Charlotte Harbor the Florida Southern Railroad has founded the town of Punta Gorda, its present terminus. "Saint James City" has been laid out on Pine Island, in San Carlos Bay, and is attracting settlers.

At present 11 feet can be carried at low water through Charlotte Harbor into the mouth of Pease River opposite the wharves at Punta Gorda, and 11 feet through San Carlos Bay to the wharf at Pine Island. The average rise of the tide is 1.14 feet in Charlotte Harbor and 1.34 feet in San Carlos Bay. The average draught of steam and sailing vessels in the Gulf trade is less than 10 feet. When the country becomes more settled the interests of commerce will probably demand that a deep channel be provided for one of the ports of this harbor—Punta Gorda, Saint James City, or Punta Rassa.

It is my opinion that the existing facilities are sufficient to satisfy all legitimate demands of the present commerce.

I do not regard these harbors as now worthy of improvement by the United States.

Respectfully submitted.

W. M. BLACK,
First Lieutenant of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 15.

PRELIMINARY EXAMINATION OF CLEAR WATER HARBOR, INCLUDING ANCLOTE AND SAINT JOSEPH'S BAYS AND THE NARROWS INTO BOCA CIEGA BAY, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz:

* * * * * * *

CLEAR WATER HARBOR, INCLUDING ANCLOTE AND SAINT JOSEPH'S BAYS AND THE NARROWS INTO BOCA CIEGA BAY.

* * * * * * *

An examination and survey of Clear Water Harbor, including Anclote and Saint Joseph's Bays was made in January, 1885, under the direction of Capt. R. L. Hoxie, Corps of Engineers, as reported in Appendix p. 15, Annual Report of the Chief of Engineers, United States Army, 1885. For a detailed description of this harbor I would respectfully invite attention to that report.

A narrow rocky channel, "The Narrows," connects Clear Water Harbor with Boca Ciega Bay. This is very shallow and contains only from 1 to 3 feet of water. Boca Ciega Bay in its physical characteristics resembles Clear Water Harbor. It is generally shallow, varying in depth from one-half to 5 feet, with a few deeper holes. At its south end a channel runs from deep water of the Gulf to Point Pinellas, obstructed at its outer end by a bar having only 6½ feet on its crest. Along the Narrows and bay are the following settlements: Anona, John's Pass, Bonifacia, and Pinellas, containing in all about 200 inhabitants. These towns, with Tarpon Springs, Anclote, Yellow Bluff, Dunedin, and Clear Water Harbor on Anclote and Saint Joseph's bays and Clear Water Harbor, have a total population of about 2,000.

The steamer *Governor Safford* makes semi-weekly trips each way between Cedar Keys and Tampa. At Anclote she is met by the steamer *Mary Disson*, which receives at that place the passengers and freight for all towns north of the Narrows. The other places are served by sailing vessels meeting the *Safford* or going direct to Tampa or Cedar Keys. During the past year the *Mary Disson* carried about 700 tons of freight and about 300 passengers.

The town of Tarpon Springs is growing rapidly, and is becoming a popular winter resort. The bayou (Anclote River, not included in bill) which connects it with Anclote Bay is badly obstructed by narrow oyster-bars. With this exception the settlements above named have all the commercial facilities required by their present needs. I do not deem these bays worthy of improvement at present.

I have been unable to obtain any exact commercial statistics.

Respectfully submitted,

W. M. BLACK,
First Lieut. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 16.

PRELIMINARY EXAMINATION OF WAKULLA RIVER, FLORIDA, FROM ITS MOUTH TO WAKULLA SPRINGS.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz:

* * * * * * *

WAKULLA RIVER, FROM MOUTH TO WAKULLA SPRINGS.

* * * * * * *

The Wakulla River has its source in the Wakulla Spring in Wakulla County, Fla., and flows southeast into the Saint Mark's River at Saint Mark's, Fla. Its length is about 12 miles. Its width varies from 50 to 200 feet, and the depth from 12 feet to 1 foot. The water is clear. Excepting where the cross-section is contracted the flow is sluggish. The bottom is usually sand overlying rock. In the deeper places the rock is exposed. For 2 miles from its source the stream is so broad as to become almost a marsh at low water, with a soft, muddy bottom, badly obstructed by grass, lily pads, and weeds. Through this broad bed there are various channels in the soft mud, having a depth of from one-half to two feet. The banks are well wooded and generally low and swampy, for much of the distance being submerged at high water. The influence of the tide is felt for almost the entire length of the river. The river is crossed by two wooden trestle bridges, one 4 and one 8 miles from its mouth. The floor-beams of these bridges are about 6 feet above the low-water surface. At one time the country in the vicinity was all under cultivation. Tar and turpentine were manufactured and carried down in flats to Saint Mark's. Now the population is very sparse and but few products are raised.

It is desired by some of the property owners in that vicinity to have the stream deepened to permit navigation for boats drawing 6 feet of water. The objects are to permit the inhabitants of the country west of the Wakulla to obtain and ship their goods via the railroad at Saint Mark's and the river (thus saving 15 miles of hauling over bad roads), and to make an easier route for tourists to Wakulla Springs, with the hope of building up a resort there. A river boat drawing not more than 2 feet of water would fill all present needs and could be now run on the river if the bridges were suitably arranged and a small sum expended in clearing out the grass and a few snags from one channel in the upper river.

There is no commerce on the river at present, and I was unable to find any general demand for its improvement.

In my opinion the facilities are sufficient for the present commercial necessities, and the river is not now worthy of improvement by the General Government.

Respectfully submitted,

W. M. BLACK,
First Lieut. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 17.

PRELIMINARY EXAMINATION OF THE CHANNEL FROM HAUL-OVER, ON INDIAN RIVER, TO GILBERT'S BAR, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz:

* * * * * * *

SURVEY OF THE CHANNEL FROM HAUL-OVER, ON INDIAN RIVER, TO GILBERT'S BAR.

* * * * * * *

A careful examination of this river was made between the limits named. It was found that the charts of the U. S. Coast and Geodetic Survey, numbers 463, 464, 464 c, d, e, f, g, h, and 162, covering the entire distance, are accurate and sufficiently detailed for all general purposes. No fault is found with them by the pilots navigating the river. I do not, therefore, consider a resurvey necessary.

From interviews with some of the leading inhabitants of the district I found that what is desired is the improvement of the lower river by removing oyster-bars and straightening the channel.

Over 6 feet of water exists in the channel from opposite the "Haul-over" to a point 6 miles above the mouth of the San Sebastian Creek, a distance of 55 miles. From there to the Indian River Inlet the average channel depth is 5 feet, with numerous bars having a least depth of from 3¼ to 4 feet. From Indian River Inlet to a point 2⅜ miles north of Gilbert Bar there is again an average depth of more than 6 feet.

The steamer *Indian River*, drawing from 2 to 3 feet of water, makes three trips per week over the lower river between Eden and the railroad at Titusville. She has no difficulty in carrying all of the freight offered. Owing to the very crooked channel near "the Narrows," she does not run at night through this part of the river. By the aid of range stakes and a powerful head-light this delay could be avoided. The country is fast filling up, and the shipments of fruits and vegetables are increasing so rapidly that in the near future the needs of commerce may be sufficient to warrant the straightening of the channel. I do not regard this river as being worthy of improvement now.

I have been unable to obtain even an approximate estimate of the commerce.

Respectfully submitted,

W. M. BLACK,
First Lieut. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX P.

IMPROVEMENT OF CERTAIN RIVERS IN THE STATES OF FLORIDA, GEORGIA, AND ALABAMA.

REPORT OF CAPTAIN R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. **Apalachicola River, Florida.**
2. **Apalachicola Bay, Florida.**
3. **La Grange Bayou, Florida.**
4. **Pensacola Harbor, Florida.**
5. **Choctawhatchee River, Florida and Alabama.**
6. **Escambia and Conecuh Rivers, Florida Alabama.**
7. **Oconee River, Georgia.**
8. **Ocmulgee River, Georgia.**
9. **Oostenaula and Coosawattee Rivers, Georgia.**
10. **Flint River, Georgia.**
11. **Coosa River, Georgia and Alabama.**
12. **Chattahoochee River, Georgia and Alabama.**
13. **Tallapoosa River, Alabama.**
14. **Cahawba River, Alabama.**
15. **Alabama River, Alabama.**

EXAMINATION.

16. **Flint River, Georgia, from Montezuma to Old Agency.**

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., August 15, 1887.

GENERAL: I have the honor to transmit herewith annual reports and summaries upon the river and harbor improvements under my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

R. L. HOXIE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

P 1.

IMPROVEMENT OF APALACHICOLA RIVER, FLORIDA.

The approved project for the improvement of this river contemplated securing a channel 100 feet wide and 6 feet deep at low water, by removing snags and overhanging trees as well as widening and straightening Moccasin Slough, the estimated cost being $80,333.

The following appropriations have been made:

By act of Congress approved June 23, 1874	$10,000
By act of Congress approved March 3, 1875	10,000
By act of Congress approved June 18, 1878	8,000
By act of Congress approved March 3, 1879	5,000
By act of Congress approved June 14, 1880	2,000
By act of Congress approved March 3, 1881	1,500
By act of Congress passed August 2, 1882	2,000
By act of Congress approved July 5, 1884	1,000
By act of Congress approved August 5, 1886	1,000
Total	40,500

The improvement may be considered as completed as projected, the river being in good navigable condition, and only requiring the removal of the annual accumulation of snags and overhanging trees, and such work as can be done with the amount of $2,000, which has been estimated as necessary annually for preserving the improvement.

The expenditure of $39,858.57 has effected this object.

During the past fiscal year, the steam snag-boat *Chattahoochee*, recently constructed for the Chattahoochee River, Georgia and Alabama, and loaned to the Apalachicola improvement for this purpose, was employed for about one month in December, 1886, and January, 1887, in removing 33 logs and snags from the river and 141 overhanging trees from the banks.

By direction of the Chief of Engineers, I relieved Capt. William M. Black, Corps of Engineers, of the charge of this work on April 18, 1887.

The balance available and the appropriation asked for are to be applied to preserving the improvement by the removal of obstructions according to the project.

The estimated annual cost of preserving and maintaining this improvement is $2,000.

Apalachicola River is in the collection district of Apalachicola, Fla., which is the nearest port of entry. The nearest light-house, Cape St. George Light. The nearest fort, defenses of Pensacola, Fla. Amount of revenue collected during the past fiscal year, $1,967.89.

For commercial statistics see annual reports on improvement of Apalachicola Bay, Florida; Chattahoochee River, Georgia and Alabama, and Flint River, Georgia.

Money statement.

July 1, 1886, amount available		$182.68
Amount appropriated by act approved August 5, 1886		1,000.00
		1,182.68
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$475.35	
July 1, 1887, outstanding liabilities	19.75	
		495.10
July 1, 1887, amount available		687.58
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,000.00

P 2.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

A bar existed at the mouth of the Apalachicola River, extending from half a mile below the town of Apalachicola, Fla., to the lower anchorage. The minimum depth of water over this bar was 3½ feet. The plan of improvement adopted was the deepening of the channel to 11 feet, with a width of 100 feet (see Annual Report of the Chief of Engineers for 1879, pages 823 and 824), the work to be done under contract, by dredging, at an estimated cost of $100,000.

As stated in previous reports, there was but little chance of the dredged channel maintaining itself unless entirely opened. The appropriations heretofore made have not permitted this to be done; and on each occasion part of the old work had to be done over. On this account the original estimate will have to be increased by the cost of the additional dredging required, and it seems probable that this work must be supplemented by dikes or jetties to preserve the channel. It has been estimated that the latter will cost not less than $83,000.

The expenditure of $59,030.69, under five contracts, has resulted in a channel-way 2,723 feet long, 60 feet wide, and 9 feet deep at mean low water on the 30th of June, 1887, this being the work of the last fiscal year; also a channel elsewhere across the Apalachicola Bar having such residual depth as to permit its use for tugs drawing 7 feet of water, except during the prevalence of "northers." The material removed was, in many places, apparently of recent deposit, and to some extent sawdust from the saw-mills. To complete the project, about 158,000 cubic yards of material remains to be dredged, of which 8,000 cubic yards are under contract, leaving about 150,000 cubic yards for which no funds are available.

During the past fiscal year an appropriation of $12,000 having been made by the act approved August 5, 1886, Captain Black recommended the expenditure of $2,000 of this at Carrabelle, for making a channel 30 feet wide and 8 feet deep, the remainder to be expended upon the Apalachicola Bar, in making a channel 60 feet wide and 8 feet deep at mean low water. The project was approved October 26, 1886, and proposals were advertised for November 22, 1886, and opened December 22, 1886. The contract was awarded to Mr. Seth N. Kimball, and contract entered into with him January 26, 1887. Under this contract work was commenced at Carrabelle on March 31, 1887, and completed April 20, 1887; 4,607 cubic yards of material being dredged, making a channel 1,604 feet long and 30 feet wide and 8 feet deep.

Work was then commenced at Apalachicola Bar and is now in progress. Up to June 30, 1887, 18,885 cubic yards have been dredged, opening a channel 2,723 feet long, 60 feet wide, and 9 feet deep at mean low water.

It has been thought that if the cut upon this bar could be carried through it in one operation, the silting of the channel would take place much less rapidly. It is found that the channel fails to maintain itself, but it has never been possible, under appropriations heretofore made, to ascertain whether this supposition is well founded, because each appropriation has been insufficient to accomplish the purpose. This is the case with the present appropriation. The practical effect is only to make an elongated hole in the bar, which is of no advantage to navigation, because vessels drawing the depth of water which this cut will give can not get into it over the bar. For this reason it is urgently recommended that the whole amount necessary to complete this improvement be provided in one appropriation.

The balance available, with the appropriation asked for is to be used in extending, widening, and deepening the cut by dredging, under the approved project.

The probable annual cost of preserving and maintaining this improvement is not known.

Money statement.

July 1, 1886, amount available		$696.73
Amount appropriated by act approved August 5, 1886		12,000.00
		12,696.73
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,727.42	
July 1, 1887, outstanding liabilities	4,745.62	
		9,473.04
July 1, 1887, amount available		3,223.69
Amount (estimated) required for completion of existing project		56,696.73
Amount that can be profitably expended in fiscal year ending June 30, 1889		56,696.73

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging in Apalachicola Bay, Florida, and at the mouth of the Carrabello River, Florida, received and opened by Capt. William M. Black, Corps of Engineers, on December 22, 1886.

No.	Name of bidder.	Dredging, per cubic yard.	
		Apalachicola Bay.	Carrabello River.
		Cents.	*Cents.*
1	Geo. C. Forbes & Co	39	30
2	Rittenhouse Moore	$35\frac{1}{4}$	$48\frac{1}{4}$
3	John H. Gardner	35	45
4	S. N. Kimball (lowest bidder)	$34\frac{9}{16}$	$34\frac{3}{16}$

COMMERCIAL STATISTICS, 1880.

Amount of revenue collected at the port of Apalachicola, Fla., during the fiscal year ending June 30, 1880, $292.50.

Marine hospital dues collected, $892.81.

	Vessels.	Tons.
Coastwise arrivals	24	6,265
American from foreign countries	6	2,270
Foreign from foreign countries	1	465
Total	31	9,000
Coastwise clearances	33	7,774
American vessels to foreign countries	4	913
Vessels owned in this district	27	1,459

CUSTOM-HOUSE RECEIPTS, PORT OF APALACHICOLA, FLORIDA, DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Duties on imports	$718.13
Tonnage tax	881.73
Marine-hospital tax	
Fees, penalties, and forfeitures	10.00
Official fees	304.03
Miscellaneous	44.00
Total	1,967.89

Shipping at the port of Apalachicola, Fla., during fiscal year ending June 30, 1887:	
Vessels entered	76
Vessels cleared	78
Aggregate tonnage of vessels:	
Entered	30,545
Cleared	33,686
Number of vessels employed in the traffic of Apalachicola Bay, Florida, during fiscal year ending June 30, 1887	59
Number of feet of timber and lumber exported	24,616,058
Estimated number of sail vessels and river steam-boats arrived at and departed from the port of Apalachicola, Fla., during the fiscal year ending June 30, 1887	274
Estimated aggregate tonnage of such sail vessels and river steam-boats	34,000

VALUE OF EXPORTS AND IMPORTS AT THE PORT OF APALACHICOLA, FLORIDA, DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Value of exports to foreign ports	$136,356.00
Value of exports to coastwise ports	150,916.00
Total value of exports	287,272.00
Value of imports from foreign ports	251.18
Value of imports from coastwise ports	100,000.00
Total value of imports	100,251.18
Total value of imports and exports	387,523.18
Estimated value of exports to coastwise ports by sail vessels and river steam-boats	137,000.00
Estimated value of imports from coastwise ports by sail vessels and river steam-boats	324,000.00

CUSTOM-HOUSE, APALACHICOLA, FLA., COLLECTOR'S OFFICE,
January 1, 1887.

* * * * * * *

A few years since first-class freights were $2 per 100 pounds from New York, when later there was a reduction to $1.50, and they are now at $1.30 per hundred pounds. Again, on guano, the rate from Savannah to river points before the deepening of the bar was from $6 to $8 per ton, but after the first cargo of guano received here the railroad companies cut the rate to $3 per ton, which has remained about so, but only for the reason that the guano dealers hold over the railroad companies the threat to ship to Apalachicola by sail again, but shipments will no doubt all come via this port the moment there is a permanent 10-foot channel.

* * * * * * *

J. E. GRADY,
Collector of Customs.

P 3.

IMPROVEMENT OF LA GRANGE BAYOU, FLORIDA.

The La Grange Bayou extends about 2 miles in a northeasterly direction from the north side and near the head of the Choctawhatchee Bay, and into it flows Cedar Creek, a deep stream from 90 to 160 feet wide, on which is situated the town of Freeport, 1½ miles above the bayou.

The plan of improvement adopted was made pursuant to an examination of this bayou in 1881, under an act of Congress approved March 3, 1881, and contemplates the deepening of the channel through the bayou so as to admit the passage of vessels drawing 4½ feet at mean low water; the work to be done by dredging.

The original estimate of cost of this improvement is $19,994.30. It is thought that the improvement will be reasonably permanent.

Up to June 30, 1887, there has been expended on this work the sum of $2,000, allotted from the appropriation of $20,000 made by an act approved August 2, 1882, for the improvement of the Choctawhatchee River, Florida, the two improvements being closely related. The result has been to secure a channel 5 feet deep at mean low water.

During the past fiscal year no work has been done. It is proposed to expend the funds on hand and the appropriation asked for in widening the existing channel and in removing the remaining obstructions.

There is no working plant upon this improvement. It is thought that the amount asked for ($5,000) will be sufficient to afford proper facilities to the commerce of this bayou.

The annual cost of maintaining and preserving this improvement is not known.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000.00
July 1, 1887, amount available	2,000.00
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon La Grange Bayou, within the limits of this improvement, a total assessed valuation of real and personal property amounting to $244,506, and a total taxation of $3,362.

Mr. A. McGillis, of Freeport, Fla., states that "since the building of the Pensacola and Atlantic Railroad the commerce at our place and that through La Grange Bayou, in the way of general merchandise, has diminished one-half; but that in the way of lumber and timber continues about the same, the amount passing through the bayou approximating annually 3,000,000 feet. The falling off in the merchandise commerce is due mainly to the competition of the Pensacola and Atlantic Railroad on the one hand and the lack of depth of water in said bayou.

* * * * * * *

Imports, general merchandise, when work of deepening channel through La Grange Bayou was commenced (annually)	$100,000
Exports at above time, general merchandise	$50,000
Imports since work was done (annually)	$50,000
Exports since work was done (annually)	$25,000
Exports of lumber and timber when work began and since it was done (annually) feet	3,000,000
Number of schooners engaged in the commerce	23
Aggregate tonnage of same	800
Number of sloops (rigged vessels)	5
Aggregate tonnage of same	45
Number of steam vessels	2
Aggregate tonnage of same	75

IMPROVEMENT OF HARBOR AT PENSACOLA, FLORIDA.

The improvement of this harbor was commenced in 1878 by the removal of certain wrecks forming obstructions to navigation. In 1879 a survey was made for the purpose of ascertaining the extent and probable cause of the shoaling of the main ship-channel at a point known as the "inner bar," and pursuant to this survey, which was referred to the Board of Engineers on Fortifications and Harbor Improvements, a plan of improvement was adopted which contemplates the temporary relief of navigation by dredging a channel across the inner bar, and the preservation of the shore-line at the site of Fort McRee, by the construction of jetties and shore protection, for the purpose of protecting the site for defensive works, and preventing further changes in the tidal currents, the channel to be dredged to a depth of 24 feet, with a width of not less than 300 feet.

The ultimate cost of this work is not estimated in the original project, which assumes that it will exceed $150,000. It is now estimated that $40,000 will be required for completion, making the total cost of the work $255,000. At the date of the original project, the proposed channel required the removal of 36,000 cubic yards of sand. On June 30, 1886, 142,000 cubic yards had been removed, and 40,000 cubic yards remained to be excavated. It is estimated that the amount is now 80,000 cubic yards. The cost of maintenance depends upon the rate at which the dredged channel will continue to fill, and upon the cost of maintaining the works of shore protection in their exposed position at Fort McRee. This cost enters largely into the expenditures up to the present time, not only for redredging the channel but for restoring the shore protection. The rate of silting up in the channel appears to have diminished since the shore-line has been held by the works at Fort McRee.

The expenditure up to the present time of $203,187.62 has resulted, as to the channel, in obtaining temporarily a depth of 24 feet at mean low water over the inner bar, with a width of 120 feet. This increased width and depth were not maintained by the tides, and the channel has required redredging. On June 30, 1887, a least depth of 22 feet existed. The work of shore protection has resulted in arresting the process of abrasion and advancing the shore-line about 250 feet, while the 12, 18, and 24 foot curves of the western channel fronting this shoreline have also advanced. North of the work at Fort McRee the shoreline has not materially changed, the point being held by the works. To the west of this point, towards the mainland, the shifting sand-banks which mark the entrance to the lagoon have moved southward, and are to a great extent covered by the débris of the fort, which has been washed around. This work may be regarded as permanent when the jetties are protected by suitable coping and slope protection. It would probably require after that only very slight annual repairs. The channel must be dredged continuously during favorable weather, at an annual cost not yet ascertained.

During the month of November, 1886, a pile bulkhead was constructed around the abutment of the north jetty for the purpose of preserving it against the winter storms. During the months of December, 1886, and January and February, 1887, a new wharf was constructed to receive stone, 130 piles being driven and 488 linear feet of superstructure built.

Under a contract with Mr. Francis H. Smith, dated December 14, 1886, 446 tons of stone were delivered during the month of February, 1887, and stored at Fort McRee. No more stone was received up to June 22, 1887, when the original contract expired. An extension of time was given to July 31, 1887. Delivery under this contract has been unnecessarily delayed, and the advantage of a favorable season of the year has been lost. Frequent storms are liable to occur after August 1, with possible injury to the wharf and greater risk to vessels.

Miscellaneous work consisted in the construction of a new pile-driver, repairing two brush flats and boats, and the care of plant.

The work has been in charge of Assistant Engineer Hiram Haines to December 1, 1886, and of Assistant Engineer J. E. Turtle since that date.

In the latter part of May, 1887, the attention of this office was called to the wreck of a full rigged ship, *Bride of Lorne*, upon the middle-ground in Pensacola harbor. Careful examination showed that the position and character of the wreck was such as to endanger navigation and seriously obstruct it. The authority of the Secretary of War having been obtained for the removal of the wreck under the provisions of section 4 of the river and harbor act approved June 14, 1880, proposals have been invited for such removal.

It is proposed to apply the funds remaining on hand to the purchase of stone for shore protection, and the appropriation asked for to the completion of the works of shore protection at the site of Fort McRee in such manner as will make them reasonably permanent, and to the continuance of the work of dredging the inner bar for the relief of navigation. Up to this time the works of shore protection, having been of a tentative character, are perishable, and must be promptly strengthened, or they will be destroyed, with the resulting loss of every advantage gained hitherto. These works are exposed to the action of violent storms from the Gulf, the waves which break upon the shore at this point having great destructive power.

No appropriation having been made for the fiscal year ending June 30, 1888, no funds have been available for dredging; for the same reason work upon the shore protection must be suspended, with probably serious injury to the work.

No working plant is available for the work of dredging in the harbor, which must be done under contract, or by the hire of a suitable plant.

Money statement.

July 1, 1886, amount available		$2,776.01
Amount appropriated by act approved August 5, 1886		20,000.00
		22,776.01
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$10,963.63	
July 1, 1887, outstanding liabilities	387.55	
		11,351.18
July 1, 1887, amount available		11,424.83
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received and opened October 28, 1886, for rock for construction of jetties at Fort McRee, Pensacola Harbor, Fla., in accordance with advertisement of October 11, 1886.

No.	Name of bidder.	Price.			Date of delivery.	Remarks.
		Class No. 1.	Class No. 2.	Class No. 3.		
		Per ton.	*Per ton.*	*Per ton.*		
1	Francis H. Smith, New York, N. Y.	$3.94	$3.94	$4.94	200 days after date of notification of award of contract.	No seal attached to signature.

COMMERCIAL STATISTICS.

Value of imports and exports, Port of Pensacola, Fla.

	1879.	1887.
Exports to foreign ports	$2,102,477	$2,068,140
Exports to coastwise ports	594,349	473,169
Total value of exports	2,696,826	2,541,309
Imports from foreign ports	Unknown...	56,214
Imports from coastwise ports	... do	(*)
Total value of imports	....	56,214

* No record kept.

Custom-house receipts, Port of Pensacola, Fla.

Description.	1879.	1887.
Duties on imports	$13,222.00	$7,197.85
Tonnage tax	34,820.00	13,063.80
Marine hospital tax	1,773.00	....
Fees, penalties, and forfeitures	530.00	118.68
Inspection of steam vessels	400.00	10.00
Immigrant fund	....	21.50
Official fees	2,843.00	2,564.83
Miscellaneous	....	515.05
Total	53,588.00	23,401.80
Number of vessels entered at the port of Pensacola, Fla	481	518
Number of vessels cleared at the port of Pensacola, Fla	448	499
Aggregate tonnage of vessels entered	227,824	332,160
Aggregate tonnage of vessels cleared	218,955	316,420
Number of vessels employed in the traffic of Pensacola Harbor, Fla	Unknown...	120
Number of bales of cotton exported	....do........	....
Number of feet (B. M.) of lumber and timber exported	....do........	229,908,468

P 5.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA

The States of Florida and Alabama have appropriated $40,000 heretofore for the improvement of this river from Geneva to its mouth. The present plan of improvement, made pursuant to an examination under authority of an act of Congress approved in 1871, and a subsequent examination under an act approved March 3, 1879, was adopted in 1872 and modified in 1880, and contemplates the improvement of the river from its mouth to Newton, Ala., a distance of 252 miles, so as to obtain a low-water navigable channel from its mouth to Geneva, and a navigable high-water channel from Geneva to Newton, Ala., by the removal of snags and logs from the channel and overhanging trees from the banks.

The original estimate of cost of this improvement, as amended in 1880, is $122,832. The limited appropriations have compelled slow progress of the work, and the annual accumulation of obstructions due to freshets in the river have been added to the work contemplated by the estimate. The improvement, with an annual expenditure for maintenance and repair, will have that degree of permanence which can be given by works of contraction to a river with a movable bottom and caving banks. This river is obstructed by two bridges within the limits of the proposed improvement. It is quite seriously obstructed in consequence of the practice of driving logs instead of rafting them. A large proportion of the obstructions removed from the channel are saw-logs. If the permanent improvement of this river is contemplated, the practice of driving logs should be prohibited by law.

The expenditure of $80,781.20 has resulted in giving a navigable channel at mean low water from the mouth of the river to Geneva, and a partially improved channel from Geneva to Pates Creek, a distance of 25 miles (12 miles below Newton, Ala.).

During the past fiscal year the work of improving this river was resumed with the snag-boat *Choctawhatchee* at Caryville, Fla., in September, and the river cleared of the principal obstructions between this point and Geneva, Ala. In December the snag-boat *Choctawhatchee* was put at work between Geneva and Newton, together with another smaller boat, upon which a separate party was employed. These two parties have been continuously employed since that time between Newton and Pates Landing, and a third party, organized during a favorable stage of water in the river, was also employed between Newton and Pates Landing, clearing the river of obstructions successfully to within 5 miles of the latter point. Similarly, a small party was organized and successfully employed during low water in the month of June, on the rock shoals below Geneva, removing from that point some 3,000 loose rock, stones, and bowlders. In all, 384 overhanging trees were cut and trimmed, 15,500 logs and snags and 414 cubic yards of rock removed from the channel, an aggregate distance being worked over by the several parties together of 49¾ miles. In addition to the work on the river, the snag-boat *Choctawhatchee* was extensively repaired.

It is proposed to apply the funds remaining on hand and the appropriation asked for to the further improvement of this river by the removal of logs and snags from the channel, cutting through rock shoals, and removing bars by works of contraction.

The value of the working plant upon this improvement is estimated at $2,292. When worked to its full capacity, an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant, about $30,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

July 1, 1886, amount available		$354.05
Amount appropriated by act approved August 5, 1886		15,000.00
		15,354.05
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$9,135.25	
July 1, 1887, outstanding liabilities	933.82	
		10,069.07
July 1, 1887, amount available		5,284.98

Amount (estimated) required for completion of existing project	$35,832.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 shows that in the several counties which border upon this river the total assessed valuation of property, real and personal, is $1,446,030, and the total taxation $24,278.

Previous to this improvement, the commerce of the river was represented by the traffic of one steamer of 100 tons burden, in the carrying trade between Caryville, Fla., and Geneva, Ala. As the work progressed and confidence was established, another steamer was purchased of 125 tons, and then a third of 135 tons; all of which were successfully operated during the past season, together with the steamer *Night Hawk*, in the carrying trade of Newton, Ala. The large boats made several trips as far up the river as Pates Landing, carrying 100 tons of guano. Flour has been carried up the river at a saving of $1 per barrel over other transportation. Other freights have a reduction of 20 per cent. The ratio of exchange between cotton and guano was reduced from 425 pounds of cotton per ton of guano to 400 pounds.

P 6.

IMPROVEMENT OF ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA.

The plan of improvement for these rivers, adopted pursuant to partial examinations and surveys made in 1878 and 1879, contemplates the removal of logs and snags and other obstructions from the channel, closing cut-offs, and cutting through the rock shoals from the mouth of the river in Pensacola Bay to Indian Creek, a distance of 273 miles, for the purpose of facilitating the movement of logs and rafts down the river, affording at the same time facilities for steamboat navigation.

The original estimate of cost of this improvement is $87,430. The river has generally a movable bottom and caving banks, bordered by a thick growth of timber, with only an occasional rock shoal. The annual accumulation of obstructions, due to freshets, has been added to the work contemplated by the original estimate. This will require constant attention and continued appropriations, fresh obstructions being brought in annually by the freshets of winter and spring. The improvement will have that degree of permanence, with an annual expenditure for maintenance, which can be given to such a river by work of this character.

The practice of driving logs on this river and of building booms, occupying a large proportion of the channel, should be prohibited by legislation. A large proportion of the obstructions removed from the channel are saw-logs.

The expenditure of $38,806.82, up to June 30, 1887, has resulted in dredging a channel through the bar at the mouth of the Escambia River, and in the removal of obstructions to navigation, so that at the present time the river is navigable at ordinary stages of water for steam-boats drawing 5½ feet of water from Ferry Pass to Skinner's Landing, a distance of 17 miles, and for boats drawing 3 feet to the Alabama State line. Above this point the channel has been improved sufficiently to give increased facilities to the commerce of the river.

During the past fiscal year two parties were organized for work on this improvement with skiffs and flats. One of these commenced work near Andalusia, Ala., on October 1, and was disbanded near Gay's Lake, between Pollard and Brewton, on December 8, 1886, because of high water. The second party was organized on November 15, 1886, at Brewton, Ala., and disbanded December 11, 1886, near Gay's Lake, for the same reason. A total distance of 99 miles of river was worked over and the following work accomplished:

Overhanging trees felled and cut up	338
Overhanging trees trimmed	37
Logs (drift, etc.) on banks cut up	440
Stumps on bank cut level	245
Logs and snags removed from channel	1,509
Cubic yards of rock removed from channel	45

The snag-boat for this improvement having been found to be unserviceable had been condemned prior to the opening of the working season and no other snag-boat was then available. On the 13th of June, 1887, the authority of the Chief of Engineers was obtained for the transfer of the snag-boat *Cahawba* to this improvement, where it will be able to do effective service with adequate appropriations. The work has been in charge of Mr. Hiram Haines.

It is proposed to apply the funds remaining on hand and the appropriation asked for to the continuation of the work of improvement by the removal of logs, snags and other obstructions from the channel, closing cut-offs, and cutting through rock shoals.

The value of the working plant upon this improvement is estimated at $8.346. When worked to its full capacity an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant, about $30,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

July 1, 1886, amount available		$1,160.16
Amount appropriated by act approved August 5, 1886		12,000.00
		13,160.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,853.18	
July 1, 1887, outstanding liabilities	451.46	
		3,304.64
July 1, 1887, amount available		9,855.52

Amount (estimated) required for completion of existing project	35,376.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This river flows through a very extensive lumber district of long-leaf yellow pine, contributing largely to the export trade of Pensacola, Fla.

The census of 1880 gives for the counties bordering upon this river a total assessed valuation of real and personal property amounting to $5,649,647, and a total taxation of $118,767.

An effort has been made to obtain commercial statistics from parties presumably interested in the navigation of those rivers, but without success.

During the fiscal year ending June 30, 1886, this stream carried down 4,140,000 cubic feet of sawn timber; 1,008,000 cubic feet of hewn timber, 90,000 saw logs, and 2,500 cedar logs. During the season of high water occasional trips were made by steam-boats between Pensacola, Bluff Springs, and Andalusia, transporting merchandise and agricultural products.

P 7.

IMPROVEMENT OF THE OCONEE RIVER, GEORGIA.

The State of Georgia has expended about $35,000 for the improvement of this river. The first examination of the river by authority of the United States was made in 1874 and a plan of improvement adopted, contemplating the removal of obstructions from the channel, to secure a depth of about 3 feet at low water from Milledgeville to the Ocmulgee River. The river has generally a movable bottom and caving banks covered with timber. The improvement will have that degree of permanence which attaches to works of contraction for deepening the channel over sand-bars and continuous removal of logs and snags.

The original estimate of cost of this improvement is $50,000. To this must be added the cost of removing obstructions brought into the river channel by freshets since the date of the estimate.

The work done up to the present time, under the plan of improvement adopted, with an expenditure of $24,656.83, has resulted in enabling steam-boats to navigate the river at a stage of water 4 feet lower than that at which navigation was practicable before the improvement was commenced.

During the past fiscal year, under a specific appropriation of $1,500 for the section of this river between Skull Shoals and the Georgia Railroad Bridge, a working plant was provided, and a force of 6 men commenced operations, removing 129 logs, snags, and overhanging trees. The advent of high water compelled a cessation of operations, which have not yet been resumed, the nature of the work requiring that it be executed at the lowest stage of the water. For the lower river, between Milledgeville and the Ocmulgee River, no working plant is available. An effort was made to secure a suitable steam-boat, to be employed as a snag-boat, but no suitable vessel could be obtained; accordingly, plans were prepared for a steam snag-boat, to be built for the joint use of this river and of the Ocmulgee. The contract has been awarded to Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., for $8,400.

This improvement has been in charge of Mr. F. C. Armstrong.

The funds remaining on hand and the appropriation asked for can be profitably expended in the construction of this boat, paying one-half the cost, and in continuing the work of removing obstructions from the channel.

There is no working plant upon this improvement; but one-half the value of the working plant to be provided for this river in common with the Ocmulgee River is estimated at $5,000. When worked to its full capacity for one-half the working season an annual expenditure of $15,000 is required; a less expenditure with such working plant is injudicious. With an increase of working plant about $17,500 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

July 1, 1886, amount available		$0.78
Amount appropriated by act approved August 5, 1886		9,000.00
		9,000.78
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,157.61	
July 1, 1887, outstanding liabilites	66.92	
		1,224.53
July 1, 1887, amount available		7,776.25
Amount (estimated) required for completion of existing project		17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		17,500.00

Submitted in compliance with requirements of sections 2 of river and and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 gives, for the counties bordering upon this river within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $7,475,214, and a total taxation of $99,973.

An effort has been made to obtain commercial statistics from parties presumably interested in the navigation of this river, but no information has been received.

In 1885 the following-named steam-boats were employed upon this river:

	Tons.
Laurens	180
Wadley	190
Ida	250
Mary Cooper	150
North State	180

These boats carried during that year about 4,000 barrels turpentine, about 6,00 tons cotton, merchandise, provisions, etc., besides which about 20,000,000 feet of lumber were rafted down the river.

P 8.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The State of Georgia has expended about $60,000 for the improvement of this river. The first examination and survey by authority of the United States was made in 1852, and another in 1875. Subsequent to this a plan of improvement was adopted which contemplates the removal of obstructions from the channel, and cutting through rock shoals so as to obtain a navigable channel 60 feet in width and 4 feet in depth at low water from Macon, Ga., to the Oconee River.

This river has a movable bottom and caving banks, which are covered with timber. The improvement will have that degree of permanence which attaches to works of contraction under such circumstances. An annual expenditure will be required for the maintenance of the work and the removal of fresh obstructions. The navigation of this river is more or less obstructed by two bridges already constructed within the limits of the contemplated improvement, which have been heretofore reported, and the report published in Senate Ex. Doc. No. 105, Forty-ninth Congress, second session.

The original estimate of cost of this improvement is $112,480. To this must be added the cost of removing obstructions brought into the river channel since the date of the estimate by the annual freshets.

The expenditure of $57,496.30, up to the present time, under the adopted plan of improvement, has resulted in securing navigation of the river at a stage from 2 to 3 feet lower than was practicable before the commencement of the improvement.

There being no working plant available for this improvement, no work was done during the fiscal year ending June 30, 1887, except preparing plans for new steam snag-boat to be built for the joint use of this river and of the Oconee. The contract has been awarded to Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., for $8,400. The work has been in charge of Mr. F. C. Armstrong.

The funds remaining on hand and the appropriation asked for can be profitably expended in the construction of this snag-boat, paying one-half the cost, and in continuing the work of removing obstructions from the river channel.

There is no working plant upon this improvement, but one-half the value of the working plant to be provided for this river, in common with the Oconee River, is estimated at $5,000. When worked to its full capacity for one-half the working season an annual expenditure of $15,000 is required; a less expenditure with such working plant is injudicious. With an increase of working plant, about $25,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

Amount appropriated by act approved August 5, 1886		$7,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$496.30	
July 1, 1887, outstanding liabilities	66.92	
		563.22
July 1, 1887, amount available		6,936.78
Amount (estimated) required for completion of existing project		48,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $17,876,408, and a total taxation of $272,180.

In 1885, the following named steam-boats were employed in the navigation of the river: *Ida Colville, Mary Jeter, Wadley, Mary Cooper, North State, and Cumberland.*

These boats then carried about 6,800 barrels of turpentine, 28,000 barrels of rosin, and about 3,200 tons of cotton, provisions, etc. In addition to this, about 30,000,000 feet (B. M.) of lumber was rafted down the river.

Mr. John J. Johiss, mayor of Hawkinsville, Ga., under date of July 25, 1887, states that "when the improvements were begun on the Ocmulgee River the commerce thereon amounted to nothing. There were no boats on the river.

"There are now on the river at this place three steam-boats, with headquarters in the town, and there are several other boats that run lower down. There are now brought here per annum about 50,000 barrels turpentine and rosin, 500 bales cotton; $150,000 of merchandise are shipped from the town down the river on the boats, while considerable quantities of wool, staves, brick, etc., are shipped from and to here by the river on the boats.

"Since the river has been partially cleared out, so that the boats can run, the freights have been diminished very much. The river with boats running in it makes the town a competitive point, and where we use to pay $3 per bale for cotton, we now pay only $2 per bale to Savannah, and this is about a fair rate of decrease. As to the change in insurance, we are not prepared to give a definite reply, for it is impossible to estimate this.

"Our town has a fine cotton-seed oil mill, a large barrel factory, one of the best brick manufactories, as well as the best clay for brick in the State; our wool trade is large, and it would all come here from the best wool section if there were river transportation. We ship annually from twenty to twenty-three thousand bales of cotton now, and this would go by the river to a great extent if it was in proper boating condition, and we would get a large increase of cotton from the counties below on the river; or it would at least be shipped by the river."

P 9.

IMPROVEMENT OF OOSTENAULA AND COOSAWATTEE RIVERS, GEORGIA.

No work has been done on either of these rivers during the fiscal year ending June 30, 1887, nor in fact, since active operations were suspended on the Coosawattee, in October 1880, and on the Oostenaula in August, 1881. Further improvement is needed, but no further expenditure is recommended at present because the Oostenaula River has recently been obstructed by the construction of a railroad bridge a short distance above the city of Rome, Ga., by the Rome and Decatur Railroad, which is without a draw-opening and without sufficient height. As reported to this office it constitutes a greater obstruction than any existing natural obstruction in the river. It has been heretofore reported and the report published in Senate Ex. Doc. No. 105, Forty-ninth Congress, second session.

Money statement.

July 1, 1886, amount available	$1,143.71
July 1, 1887, outstanding liabilities	21.85
July 1, 1887, amount available	1,121.86

P 10.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

The plan of improvement, made pursuant to an examination and survey of this river in 1872 and 1873, modified after further examination in 1880, contemplates a low water navigable channel 3 feet deep and 100 feet wide, from the mouth of the river to Albany, Ga., a distance of 105 miles, and a navigable channel for light-draught steamers at a moderate stage of water from Albany to Montezuma, Ga., an estimated distance of 100 miles. The work to be done consists in the removal of snags and other obstructions from the channel and overhanging trees from the banks; the scouring of bars by works of contraction, and cutting of the prescribed channel through the rock reefs.

The original estimate of cost of this improvement is, from Chattahoochee, Fla., to Albany, Ga., $184,862; from Albany to Montezuma, Ga., $15,000. To the latter estimate should be added the cost of removing the annual accumulation of obstructions due to freshets in the upper river; this requires a constant annual expenditure. For the lower river, the work is principally upon the rock bottom of the river, and is of a permanent character.

The navigation of this river is more or less obstructed by five bridges, already constructed within the limits of the contemplated improvement.

The expenditure up to the present time of $103,086.24 has resulted in securing a fair navigable channel at low water from Chattahoochee, Fla., to Mingo's Island, about 11¾ miles below Albany, Ga., at which point operations were suspended at the close of last working season; and an improved high-water channel between Montezuma and Warwick, Ga., 40 miles above Albany.

The following table shows the condition of the improvement on June 30, 1887:

Names of places improved.	Number.	Miles below Albany, Ga.	Original depth.	Present depth.	Original width.	Present width.	Rock removed from each place.	Remarks.
			Ft.	*Ft.*	*Ft.*	*Ft.*	*Cu. yds.*	
Lambert's Island	1	88	1	3	....	100	714	New channel blasted.
Rob's-Rock	2	85	...	2	60	100	152	Dry bowlder removed.
Broad-Axe Rock	3	84½	½	4	50	100	48	Bowlder in mid-channel removed.
Bryant's Rock	4	79½	½	4	70	100	54	Bowlder on point removed.
Versailles Rock	5	77	½	4	50	100	415	Several reefs and bowlders removed.
Town of Bainbridge	6	75	1	4	100	100		
Three-Rock Beach	7	72	½	4	40	100	122	Loose rocks and bowlders removed.
Below Cross Chute	8	71	½	4	30	100	1,171	Do.
Cross Chute	9	64	....	4	75	100	120	Dry ledge removed to widen channel.
Fodder Stack	10	63	....	3	80	100	488	Do.
Reefs 1 to 12	11-22	63-54	1	3	40	100	1,872	Loose rocks, large bowlders, and solid ledges removed.
Cranford's Point	23	54	....	3	70	100	1,231	Dry ledge and bowlders removed.
Winding Shoals	24	53	1	3	40	100	897	Loose rocks and solid ledge removed.
Hell Gate Shoals	25	51½	....	3	....	100	3,636	New channel blasted through solid rock.
Sycamore Shoals	26	51	1	3	40	100	315	Loose rock and solid ledges blasted and removed.
Maples Chute	27	50½	....	3	20	100	2,151	New channel blasted; cut-off made and island removed.
Keaton's Lower Shoals	28	48¾	1	3	20	100	86	Large bowlders and loose rocks removed.
Keaton's Middle Shoals	29	48½	....	3	20	100	214	Do.
Keaton's Upper Shoals	30	48¼	....	3	20	75	145	Do.
Dubignion's Shoals	31	48	....	3	20	90	258	Do.
Lyons Island	32	44	2	3	20	75	92	Solid ledge and loose rocks removed.
Fish Trap	33	43½	2	3	20	100	285	Do.
Bull's Slough	34	41½	1½	3	20	100	562	Do.
Rope Work Shoal	35	41	1	4	50	50	551	Do.
Drybread Reef, No. 3	36	40½	½	5	25	75	440	Do.
Drybread Reef, No. 2	37	39¾	2	3	20	80	681	Do.
Drybread Reef, No. 1	38	39½	2	5	20	80	134	Do.
Dickerson's Shoals	39	39¼	2	3	40	80	83	Large bowlders and loose rocks removed.
Buck Shoals	40	37¾	2	4	30	100	105	Do.
Sisters Islands	41	36¾	1½	4	40	100	312	Three reefs of solid ledge and loose rock.
Kennedy's Shoals	42	35½	1	3	30	100	103	Solid ledge and loose rocks removed.
Town of Newton	43	33½	1	3	30	100	191	Large bowlders and part of island removed.
Between Newton and Ferguson's.	44	31½	2	3	50	100	40	One large bowlder removed.
Luckies Island	45	21	1½	3	30	100	838	Point on island cut off and bowlders removed.
Tea Cup Shoals	46	19½	2	3	30	100	1,951	Three separate reefs of loose rock and bowlders removed.
Squirrel Island	47	16	2	3	20	70	412	Bowlders and solid ledge blasted and removed.
Red Bluff Rapids	48	13½	....	3	....	70	2,037	Do.
Dead Man's Island	49	12	1	3	....	80	842	Do.
Mingo's Island	50	11¾	1	3	....	.....	....	Being worked on.

During the past fiscal year a small snag-boat worked by hand power was kept in service for a period of about five months between Montezuma and Warwick, removing obstructions and cutting overhanging trees, effecting the removal of 2,573 logs and snags and overhanging trees, and 76 yards of loose rock. For about the same length of time two drilling barges were kept at work on the reefs below Albany, Ga., between Tea-Cup Shoals and Mingo's Island, effecting the removal of 659 snags and overhanging trees and 4,185 cubic yards of rock. The work has been in charge of Mr. P. M. Slaughter.

The funds remaining on hand and the appropriation asked for can be profitably expended in continuing the work of cutting through rock shoals below Albany and in removing obstructions from the river channel between Albany and Montezuma.

The value of the working plant upon this improvement is estimated at $1,704.60. When worked to its full capacity, an annual expenditure of $20,000 is required; a less expenditure with the present working plant is injudicious. With an increase of working plant, about $40,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

July 1, 1886, amount available		$2,109.89
Amount appropriated by act approved August 5, 1886		20,000.00
		22,109.89
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$8,166.37	
July 1, 1887, outstanding liabilities	1,540.24	
		9,706.61
July 1, 1887, amount available		12,403.28
Amount (estimated) required for completion of existing project		83,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river within the limits of the proposed improvement a total assessed valuation of real and personal property amounting to $13,451,611, and a total taxation of $156,916.

No information has been received pertaining to the past fiscal year. The following statement is for the fiscal year ending June 30, 1886: Number of boats employed in the commerce of this river, 10; valuation, $126,000; tonnage, 1,400; draught, in feet, 2 to 5.

During the year ending June 30, 1886, these boats carried in freight, as follows:

Commercial fertilizers	tons	6,542
Iron	tons	206
Grain	bushels	27,680
Cotton	bales	22,760
Lumber	feet	4,730,000
Merchandise	bales	760
Merchandise	barrels	189,700
Live stock	head	64
Turpentine	barrels	3,000
Resin	barrels	15,000
Square and round timber	ft	3,000,000

Total valuation	$3,185,274
Total valuation of freights	40,700
Total valuation of passenger traffic	27,000
Aggregate valuation of river business	$3,252,974
Aggregate valuation in 1885	3,234,163

The large increase in our river business for the present year is mainly caused by the improved condition of the river as caused by Government appropriations, thus enabling our boats to run the year through, and, by connections with railroad points below, to offer through rates for cotton and merchandise to and from all points east and north in competition with our local railroads, thus increasing very materially the amount of business to our boats, and enabling the merchants on the river to compete in freights with other points not so favorably located.

C. E. HOCHSTRASSER,
Vice President Columbus (Ga.) Board of Trade.
E. L. WELLS, *Secretary.*

P II.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

In 1823 the State of Alabama passed an act to aid the improvement of the Coosa River, and in 1828 this river first had the attention of Congress. In 1876 an appropriation was made for improving the Coosa River between Rome, Ga., and the Selma, Rome and Dalton Railroad Bridge, which dates the beginning of the improvement of this river, according to the present project. This project contemplates the improvement of the river between these points, to give a minimum depth of 3 feet at low water, overcoming the more serious obstructions by locks and dams, and the lesser rock shoals and sand and gravel bars by rock excavation and by works of contraction, respectively.

The original estimate of cost of this improvement is $560,663. To this must be added the cost of improving about 29 miles of the river between Greensport and Gadsden, Ala., not included in any survey or estimate; also the increased cost of the better class of work adopted in the construction of locks and dams, as well as the cost of removing obstructions which accumulate annually in the river channel, and the maintenance of the works. Below Greensport the improvement is of a permanent character, consisting of locks and dams. Above Greensport the river has, generally, a moderate slope and banks not easily eroded, but, in places, a movable bottom, where works of contraction are required. The improvement of this part of the river will have that degree of permanence which attaches to works of contraction under such circumstances. An annual expenditure will be required for removing obstructions from the channel and for maintaining the works.

The navigation of this river is now obstructed by two bridges within the limits of the contemplated improvement.

The total expenditure up to the present time is $438,800.51. The channel above Greensport has been improved by straightening and widening and increasing the minimum depth from 16 inches to 2 feet. Below Greensport the work of lock and dam navigation to overcome the more serious obstructions is nearly completed.

The condition of the work on June 30, 1887, was as follows:

Lock No. 1.—Lock and dam completed and gates set up, ready to receive maneuvering machinery.

Lock No. 2.—Lock and dam completed and gates set up, ready to receive maneuvering machinery.

Lock No. 3.—Lock and dam completed and gate set up, ready to receive maneuvering machinery.

Lock No. 4.—Stone quarried and dressed, except coping, quarters for employés erected and preparation for building dam commenced.

During the past fiscal year, with the limited appropriation available, work has been done as follows:

Stripping quarry, amount of material removed	cubic yards..	86
Stone quarried	do....	707
Stone cut and dressed	do....	46
Stone transported from quarry to work	do....	1,139
Masonry laid	do....	663.51
Excavation, lock-pits, rock and earth	do....	203
Filling behind lock-walls	do....	1,655
Holes drilled for bolts, etc	lineal feet..	389
Concreting in miter sill foundation	cubic yards..	63
Repairs to coffer-dams, material used	do....	168
Gravel removed from channel below lock	do....	3,270

Gates for locks Nos. 2 and 3 completed and set up.

Stone received for dam	cubic yards..	803.59
Lumber (broad measure) received for dam	feet..	73,677

Miscellaneous repairs to coffer-dams, buildings, plant, etc., made as required.
Nine (9) buildings removed from Lock 3 and constructed at Lock 4.
Plans have been prepared for maneuvering machinery for the locks.
The work has been in charge of Mr. M. T. Singleton.

The funds remaining on hand, together with the appropriation asked for, can be profitably expended in continuing the improvement between Rome, Ga., and the Selma, Rome and Dalton Railroad Bridge, Alabama.

The value of the working plant upon this improvement is estimated at $6,432; but the work is of such character that a trifling increase in the plant is sufficient to increase very greatly the amount of work. With the present working plant an annual expenditure of $75,000 is required; a less expenditure with the present working plant is injudicious.

It is recommended that the appropriation asked for be made available, by suitable legislation, for the purchase of land required for the site of Lock 4; otherwise unnecessary delay will be incurred in the prosecution of the work.

The estimated annual cost of maintaining and preserving this improvement is $10,000.

Money statement.

July 1, 1886, amount available		$803.94
Amount appropriated by act approved August 5, 1886		45,000.00
		45,803.94
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$20,904.45	
July 1, 1887, outstanding liabilities	899.97	
		21,804.42
July 1, 1887, amount available		23,999.52

Amount (estimated) required for completion of existing project	97,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	97,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

An effort has been made to obtain commercial statistics from parties presumably interested in the navigation of this river, but no information has been received. The statistics for 1885 are as follows:

The following is a list of the boats employed on the river:

	Length at water-line.	Beam.	Tonnage.
	Feet.	*Feet.*	
Sidney P. Smith	137	23	83.40
Gadsden	164	30	133.66
Joel Marable	140	20	97.75
Hill City	140	18	75.75
To be completed by September 15, 1886	175	34	250.00

During the year ending June 30, 1885, these boats carried freight as follows:

Cotton	bales..	25,000
Grain, hay, and flour	tons..	3,500
Guano	do..	2,500
Miscellaneous merchandise	do..	5,000
Lumber	feet (B. M.)..	4,500,000
Passengers	number..	8,000

In addition to the above, about 24,000,000 feet (B. M.) yellow pine lumber was rafted to the mills on the river.

P 12.

IMPROVEMENT OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

The present plan of improvement, adopted in 1873, contemplates a low-water channel, 4 feet in depth and 100 feet in width, from Columbus, Ga., to Chattahoochee, Fla., a distance of 223½ miles, by the removal of snags and other obstructions from the channel and overhanging trees from the banks, by cutting a channel through the rock shoals and deepening sand-bars by scour.

The original estimate of cost of this improvement is $385,247.66. The limited appropriations available have compelled slow progress of the work, and have added the annual accumulation of obstructions due to freshets in the river, to the amount of work contemplated in the original estimate. There has also been added the cost of maintenance of works of contraction and of their extension, made necessary by the works themselves.

This improvement is at several points of a permanent character, the bottom of the river being of rock, and the banks not subject to erosion. At other points the river has a movable bottom and caving banks, and the improvement will have, with an annual expenditure for maintenance and repair, that degree of permanence which works of contraction can give to such a stream.

The navigation of this river is now more or less obstructed by three bridges already constructed within the limits of the proposed improvement.

The expenditure up to the present time of $205,470.58 has resulted in securing a fair navigable channel between Chattahoochee, Fla., and Eufaula, Ala., at all seasons of the year, and between Eufaula, Ala., and Columbus, Ga., at all times except during the prevalence of extreme low water.

The following table exhibits the condition of the improvement on June 30, 1887:

Number of shoal.	Names of places.	Miles below Columbus, Ga.	Miles above Chattahoochee, Fla.	Original depth.	Present depth.	Original width.	Present width.	Remarks.
				Ft.	*Ft.*	*Ft.*	*Ft.*	
1	South Commons	1	222	2	4	300	100	Brush jetties.
2	Mound Bar	7	215	2½	4	350	150	Do.
3	Abercrombie's Bar	8	214	1½	4	350	150	Do.
4	Woolfolk's Bar	9	213	1½	4	500	150	Brush jetties and shore protection.
5	Upatsie Creek	10	212	2	4	300	150	Brush jetties.
6	Fort Mitchell Bluff	14	209	2	....	30	....	Marl reef being removed.
7	Fort Michell Bluff, No. 2.	14½	208½	2	4	40	84	Marl reef removed to widen and deepen channel.
8	Little Uchee Shoals	17	206	2	4	29	65	Marl blasted and removed.
9	Reef below shoal	17½	205½	1½	4	50	60	Do.
10	Slick Bluff Shoal	18	205	....	4	39	70	Do.
11	Middle Rock	18½	204½	1½	4	30	100	Do.
12	Big Uchee Shoals	19	204	1½	4	29	80	Do.
13	Old head of Uchee	19½	203½	1½	4	40	80	Do.
14	Betton's Upper Rocks	20½	202½	....	4	40	180	Hard rock blasted and removed.
15	Betton's Lower Rocks	21	202	....	4	50	200	Do.
16	Cody's Rocks	22	201	1	4	40	100	Do.
17	Shell Creek Bar	24	199	2	4	350	350	Shore protection (needs repairs).
18	Culpepper Island	32	191	2	4	400	100	Jetties and marl reef blasted and removed.
19	Hardridges Shoals	112	111	2	4	35	100	Hard rock blasted and removed.

NOTE.—Numbers 6, 7, 8, 9, 10, 11, 12, and 13, constitute Uchee Rapids, 5½ miles long.

During the past fiscal year the new steam snag-boat *Chattahoochee* was employed for about five months upon this river between Chattahoochee, Fla., and Columbus, Ga., effecting the removal of 1,733 logs and trees and the wreck of the steamer *Chipley*. This vessel was further employed during the season upon the Apalachicola River under the direction of Captain Black. At Uchee Shoals the derrick barges and drilling scows were employed during a period of about four months, removing 3,007 cubic yards of marl and 2 logs, extending the prescribed channel for a distance of 1,740 feet. The work has been in charge of Mr. P. M. Slaughter.

The funds remaining on hand, together with the appropriation asked for, can be profitably expended in continuing the work of excavation upon the rock-reefs between Eufaula and Columbus, and in the employment of the new snag-boat for the removal of logs and other obstructions.

The value of the working plant upon this improvement is estimated at $19,600. When worked to its full capacity an annual expenditure of $20,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant about $40,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $5,000.

Money statement.

July 1, 1886, amount available		$14,161.57
Amount appropriated by act approved August 5, 1886		20,000.00
		34,161.57
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$16,613.94	
July 1, 1887, outstanding liabilities	1,042.96	
		17,656.90
July 1, 1887, amount available		16,504.67

Amount (estimated) required for completion of existing project	$162,228.69
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $20,272,775, and a total taxation of $271,573.

No information has been received pertaining to the past fiscal year. The following statement is for the fiscal year ending June 30, 1886: Number of steam-boats employed in the commerce of this river, 9; valuation, $124,500; tonnage, 1,270; draught in feet, 2 to 5.

During the year ending June 30, 1886, these boats carried in freight as follows:

Commercial fertilizers	tons	9,064
Iron	tons	240
Cotton	bales	52,580
Grain	bushels	189,760
Lumber	feet	250,000
Merchandise	bales	2,560
Merchandise	barrels	662,400
Live stock	head	420

Total valuation	$8,440.928
Total valuation of freights	90,620
Total valuation of passenger traffic	36,400
Aggregate valuation of river business	8,567,948
Aggregate value in 1885	7,945,948

The large increase in our river business is mainly caused by the improved condition of our river, as caused by the Government appropriations, thus enabling our boats to run the year through, and by connections with railroad points below to offer through rates for cotton and merchandise to and from all points east and north in competition with our local railroads, thus increasing very materially the amount of business to our boats, and enabling the merchants of the river to compete in freights with other points not so favorably located.

C. E. HOCHSTRASSER,
Vice-President Columbus Board of Trade.

E. L. WELLS,
Secretary.

P 13.

IMPROVEMENT OF TALLAPOSA RIVER, ALABAMA.

The plan of improvement, pursuant to an examination and partial survey of this river, made by an act of Congress approved June 14, 1880, contemplates obtaining a navigable channel from the mouth of the river to the foot of Tallassee Reefs, 2 miles below the town of Tallassee, a distance of 48 miles, with a least depth of 3 feet and width of 60 feet at low water, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, cutting the prescribed channel through the rock-reefs, and removing sand-bars by works of contraction.

The original estimate of cost of this improvement is $40,125. To this must be added the cost of removing obstructions brought into the river channel by freshets since the date of the original estimate. This river, within the limits of the proposed improvement, has generally a movable bottom and caving banks, with, however, a moderate slope. The river will have that degree of permanence which can be given by

Money statement.

July 1, 1886, amount available		$1,010.21
Amount appropriated by act approved August 5, 1886		7,500.00
		8,510.21
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$639.50	
July 1, 1887, outstanding liabilities	68.86	
		708.36
July 1, 1887, amount available		7,801.85
Amount (estimated) required for completion of existing project		157,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $9,118,034, and a total taxation of $156,526.

It is not thought that any vessels have made use of this river during the past fiscal year. It has been estimated that the improvement of the river will furnish transportation for cotton and merchandise to the value of about $3,870,000, and that the saving to the planters adjacent to the river, on their cotton crops alone, will be $60,000 annually; that with slackwater navigation above Centerville to Cane Creek, the main business of the river will result from the development of the immense coal, iron, and timber interests of the Cahawba Valley; but that this development will require an extension of the river improvement by a system of slackwater navigation from Centerville to Cane Creek, a distance of 21 miles.

P 15.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

The plan of improvement for the Alabama River, adopted in 1870, contemplates a channel 200 feet in width and 4 feet in depth at low water, from its mouth 50 miles above Mobile, Ala., to Wetumpka, Ala., a distance of 323 miles. Before the improvement was commenced, the channel had a least depth of about 2 feet on some of the shoals, and was obstructed by snags and overhanging trees.

The original estimate of cost of this improvement is $229,741. The work of removing the annual accumulation of obstructions in the river channel, due to freshets, has been added to the work contemplated by this estimate, as well as the cost of renewing and extending works of contraction. The improvement will have, with an annual expenditure for the maintenance of the work, that degree of permanence which can be given to such a stream by works of contraction.

The expenditure up to June 30, 1887, of $134,476.78 has resulted in opening 20 miles of the lower river, below the cut-off, before inaccessible during low water, and rendering that part of the river below Montgomery, Ala., easy of navigation during ordinary low water.

During the past fiscal year operations were resumed with the snagboat *W. J. Twining* in the latter part of August, and continued until suspended by high water in the latter part of November; 738 overhanging trees, stumps, and drift-logs were felled, cut up, or trimmed, and

1,688 logs and snags were taken up from the river channel. The work done extended from the mouth of the Tallapoosa River to the mouth of the Alabama River, the steamer making 869 miles while at work. Early in June, 1887, the *Twining* was taken to Mobile, Ala., to be laid up on the "ways" for extensive repairs. The work has been in charge of Mr. J. E. Turtle.

It is proposed to expend the funds remaining on hand and the appropriation asked for in the removal of snags and other obstructions from the channel, and in the construction and repair of works of contraction upon shoals in the river.

The value of the working plant upon this river is estimated at $18,083. When worked to its full capacity, an annual expenditure of $20,000 is required; a less expenditure with the present working plant is injudicious. With a slight increase of plant, about $40,000 can be profitably expended during the fiscal year ending June 30, 1889.

The estimated annual cost of preserving and maintaining this improvement is $10,000.

Money statement.

July 1, 1886, amount available		$285.88
Amount appropriated by act approved August 5, 1886		15,000.00
		15,285.88
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,762.66	
July 1, 1887, outstanding liabilities	431.65	
		5,194.31
July 1, 1887, amount available		10,091.57

Amount (estimated) required for completion of existing project	84,741.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $25,520,752, and a total taxation of $461,681.

Mr. A. Pope St. John, secretary of Mobile Chamber of Commerce, states that "the receipts by Alabama River from September 1, 1886, to July 1, 1887, were 50,467 bales of cotton.

"From September 1, 1885, to July 1, 1886, the receipts amounted to 42,869 bales of cotton.

"We have made an effort to get at the business or volume of business up the rivers, but failed to get the co-operation of the steam-boat interests."

Mr. T. H. Moore, general manager of Montgomery Trade Company's line of steamers, gives the following statement of freights carried by the steamers *Jewell* and *Alabama* during the fiscal year ending June 30, 1887:

	Bales
Through cotton shipped from Montgomery and Selma to Liverpool and eastern points	11,554
Local cotton from river landings to Montgomery	2,450
Local cotton from river landings to Selma	1,525
Local cotton from river landings to Mobile	5,577
Total	21,106

There are now employed upon this river six steam-boats, aggregating 1,900 tons capacity, and of this the two boats of the Montgomery Trade Company have a united capacity of 750 tons.

P 16.

PRELIMINARY EXAMINATION OF FLINT RIVER, GEORGIA, FROM MONTEZUMA TO OLD AGENCY.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., February 7, 1887.

GENERAL: In compliance with circular letter from Office of Chief of Engineers, requiring preliminary examination or survey of Flint River, from Montezuma to Old Agency, Georgia, I have caused a preliminary examination to be made of Flint River, from Montezuma to Old Agency, Georgia, for the purpose of ascertaining whether this portion of the Flint River is worthy of improvement, and the probable cost of making the survey and report contemplated by the river and harbor act of August 5, 1886, including the project and estimate of cost of improvement proper to be made.

The examination has been made, under my direction, by Assistant Engineer P. M. Slaughter, in local charge of the improvement of Flint River, and appears to indicate that this portion of Flint River is worthy of improvement, provided that the bridges which now obstruct it are furnished with suitable draw-spans.

Mr. Slaughter submits a rough estimate of the cost of improvement ($25,000) of the fifty miles of river, more or less, under consideration; and estimates the value of real and personal property in the counties interested in the proposed improvement at $7,612,941. He submits a letter from Messrs. John F. Lewis & Son, of Montezuma, Ga., in which it is estimated that the improvement of this section of Flint River will afford transportation (annually) for 3,000 bales of cotton, 500 tons of fertilizers, 200 barrels of sirup, and large quantities of general merchandise.

I am of the opinion that a survey which can serve as a basis for a project and estimate of cost of improvement proper to be made will cost about $450, and this expenditure is recommended.

Very respectfully, your obedient servant,

R. L. HOXIE.
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. P. M. SLAUGHTER, ASSISTANT ENGINEER.

In obedience to the instructions contained in your letter of November 20, 1886, as soon as the river was at a suitable stage I went to the point on Flint River known as the old "Agency," in Crawford county, Ga., so called on account of its having been a Government station and reservation. The main county road from Columbus to Macon, Ga., crosses the river at this point; distance to Macon, 33 miles. It was once the head of navigation, and two steam-boats were built there. The river for 5 miles above the Old Agency presents no obstacles to navigation.

At the time the examination was made the water in the river was 18 inches above low water. I ran a line of soundings down the middle of river, thus giving the average depth of the water. The soundings given are reduced soundings.

FIRST DIVISION—FROM THE OLD AGENCY TO THE CROSSING OF THE SOUTHWESTERN RAILROAD, NEAR THE TOWN OF REYNOLDS; DISTANCE ESTIMATED, 15 MILES.

The river at the agency is about 150 feet wide, 3½ feet deep, and flows in a southerly direction with a 1-mile current. About one-fourth of a mile below the starting point (the ferry) the first obstructions are found in the form of bowlders, which are scattered across the channel with 3½ feet of water between. These are the only rock obstructions to be met with on this portion of Flint River now under examination.

The river for the first 3 miles is comparatively straight, running through a well-cultivated country, and is free of all obstructions.

For the next 6 miles the river is narrowed to 125 feet, with long bends, and scattering snags are found in the crossings, the soundings indicating plenty of water except at one place, a sandbar on which only 2 feet was found. The same remark applies to the next 6 miles, only the number of snags in the bends, which are shorter, has increased. This brings us to the railroad bridge and end of the first division. Here the river is spanned by a covered wooden lattice bridge about 25 feet above low water, presenting a serious obstruction to navigation. The rise of the river at this point does not exceed 20 feet, as the high-water area extends to the eastward to a distance of 2 miles.

About 2 miles west of this bridge, on the railroad, is the town of Reynolds, with a population of 600; receipts of cotton, 3,000 bales.

SECOND DIVISION—FROM THE RAILROAD BRIDGE TO HOLLINSHEAD'S FERRY, 22 MILES.

Soon after leaving, the river narrows to 100 feet, with a depth from 5 to 10 feet, with a current increasing to 2 miles per hour. For the first 8 miles the bends are long, and long, straight reaches intervene; these 8 miles are reasonably free of snags, the river running through a cultivated country.

For the next 6 miles the river, retaining its width and depth with a 2-mile current, runs alternately through cleared and timbered lands. Through the timbered lands the bends are short and badly obstructed with snags.

For the next 8 miles the river narrows to 80 feet, and with an accelerated current flows through a heavily-timbered district, making very short bends, which are badly obstructed with timber from the caving banks. This is the worst obstructed section on the river. At the end of this section is Hollinshead's Ferry.

THIRD DIVISION—FROM HOLLINSHEAD'S FERRY TO MONTEZUMA.

Soon after leaving the ferry the river widens to 150 feet with no perceptible current, and resembles a lake or succession of lakes for over 4 miles, soundings indicating 4 feet. At the end of these lakes the river narrows up to a width of 80 feet, and with a 2¼ mile current sweeps through a low, heavily timbered country, making short caving bends, which are badly obstructed with fallen timber. It continues this way for 3 miles to the mouth of Whitewater Creek, the largest tributary met with.

Just before reaching the mouth of the creek the river makes an abrupt bend to the east, returning to within 200 yards of its starting point. I estimate the length of the bend to be about 1 mile. This bend is full of small timber; the width of the stream 60 feet, and depth 6 feet. Through the narrow neck of land at the head of terminus of the bend, a small cut-off was trying to form, but was prevented by the heavy growth of gum trees. In case the river is ever improved this cut-off should be closed.

From the mouth of Whitewater Creek to the upper ferry, a distance of 4 miles on the left bank, the country is high and rolling; consequently the bends are longer and less obstructed. Just below the ferry the river sweeps around a long bend to the west for a distance of 2 miles. At the foot of this bend the river is crossed by the Southwestern Railroad on a wooden lattice-covered bridge about 30 feet above low water. This bridge forms a serious obstruction to navigation at low water, and totally prohibits it at high water; 200 yards below the bridge is the head of the improvement of Flint River, between Albany and Montezuma. I estimate the entire distance from the Old Agency to Montezuma at 50 miles.

The only obstruction to navigation, besides the few bowlders at the agency, are snags and overhanging trees, the removal of which would cost $25,000, as follows:

Cost of snag-boat, with steam derrick, complete	$5,000
Removal of snags from 50 miles of river at 400 per mile	20,000
Total amount required	25,000

The value of real and personal property in the counties interested in the proposed improvement as derived from the comptroller-general's report for 1866, is as follows:

Upson	$1,504,072
Crawford	761,163
Taylor	968,101
Macon	1,611,039
Houston	2,518,101
Talbot	1,250,465
Total	7,612,941

According to the census of 1880, these counties produced 58,417 bales of cotton, divided as follows:

Upson	$8,540
Crawford	6,765
Taylor	4,854
Macon	8,834
Houston	19,099
Talbot	10,325
Total	58,417
Total value	2,920,850

I recommend this portion of Flint River as worthy of improvement for the following reasons:

(1) The large value of property interested, as officially stated.

(2) The large amount of timber, both oak and pine (now valueless), that will be rendered available.

(3) The stimulus that will be given "to the cultivation of the rich alluvial lands that border the river" by means of cheap water transportation.

(4) The check upon high railroad freights, by means of a competing water-line.

(5) Because the planters on the river, for the most part, have to haul their products over a bad road a distance of from 20 to 30 miles to market.

(6) The small amount of cost as compared with the benefits to be derived.

The project recommended is the removal of the bowlders at the Old Agency; the removal of snags, and the cutting of the overhanging timber along the banks of the stream. This would afford navigation for light-draught steamers for nine months in the year.

The cost of an instrumental survey, should it be found necessary to make one, would be $800.

The inclosed letter shows the present and expected commerce.

Very respectfully, your obedient servant,

P. M. SLAUGHTER,
Assistant Engineer.

Capt. R. L. HOXIE,
Corps of Engineers, U. S. A.

APPENDIX Q.

IMPROVEMENT OF THE HARBOR OF MOBILE; OF WARRIOR, TOMBIGBEE, AND BLACK WARRIOR RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Mobile Harbor, Alabama.
2. Black Warrior River, from Tuscaloosa to Daniel's Creek, Alabama.
3. Warrior River, Alabama.
   Tombigbee River, from Fulton to Vienna.
   Tombigbee River, below Vienna.
4. Old Town Creek, Mississippi.
5. Noxubee River, Mississippi.
6. Pascagoula River, Mississippi.
7. Harbor at Biloxi Bay, Mississippi.
8. Pearl River, Mississippi, between Edinburgh and Carthage.
9. Pearl River, Mississippi, from Jackson to Carthage.
10. Pearl River, Mississippi, below Jackson.

EXAMINATION.

11. Noxubee River, Mississippi, to ascertain whether it can be made continuously navigable by a system of locks and dams, or otherwise.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 6, 1887.

SIR: I have the honor to forward herewith annual reports for fiscal year ending June 30, 1887, for the works of improvement under my charge.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Q 1.

IMPROVEMENT OF THE HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of the harbor at Mobile, Ala., was begun by the General Government in 1827, the depth of water then being 5½ feet through Choctaw Pass, and 8 feet on Dog River Bar.

The appropriations from 1827 to 1857 were as follows:

By act of Congress, May 20, 1826	$10,000.00
By act of Congress, March 2, 1829	20,000.00
By act of Congress, June 23, 1834	10,000.00
By act of Congress, March 3, 1835	17,997.60
By act of Congress, March 3, 1837	50,000.00
By act of Congress, July 7, 1838	50,000.00
By act of Congress, August 30, 1852	50,000.00
	207,997.60
By act of Congress, March 3, 1857 (relief claim)	20,833.08
Total	228,830.68

The result obtained was a channel 10 feet deep and 200 feet wide through the pass, and the same depth with an unknown width over the bar. In 1860 the channel through the pass was found to have shoaled to 7½ feet, the depth of water on the bar remaining the same.

No further improvement was attempted until 1870.

From 1870 to 1875 the following amounts were appropriated for the purpose of obtaining a depth of 13 feet:

By act of Congress, July 11, 1870	$50,000
By act of Congress, March 3, 1871	50,000
By act of Congress, June 10, 1872	75,000
By act of Congress, March 3, 1873	100,000
By act of Congress, June 23, 1874	100,000
By act of Congress, March 3, 1875	26,000
Total	401,000

This amount was expended in dredging a channel 13 feet deep and 300 feet wide from the mouth of the Mobile River through "Choctaw Pass," and in deepening and extending that through "Dog River Bar" to the 13-foot curve in the bay. The work was completed in September, 1876, and the channel remained practically as it was dredged until the commencement of the present project February 19, 1881.

In 1878 a survey was directed to be made in order to determine whether the existing channel could be improved to a depth of 22 feet, and for this purpose Congress, by act, June 18, 1878, appropriated the sum of $10,000.

The survey was made and a report was submitted to the Chief of Engineers suggesting several plans of improvement. In March, 1880, it was finally decided to continue the former improvement by dredging to a depth of 17 feet with a uniform width of 200 feet from the 17-foot curve in Mobile River to the curve of the same depth in the lower bay, the estimated cost being $820,000. From 1878 to June 30, 1887, the following amounts have been appropriated:

By act of Congress, June 18, 1878, (survey)	$10,000
By act of Congress, March 3, 1879	100,000
By act of Congress, June 14, 1880	125,000
By act of Congress, March 3, 1881	100,000
By act of Congress, August 2, 1882	125,000
By act of Congress, July 5, 1884	200,000
By act of Congress, August 6, 1886	90,000
Total	750,000

Statement of work done under the above appropriations.

Date of act.	Name of contractor.	Contract price.	Number of cubic yards removed.	Date of commencing work.	Date of completing work.
		Cents.			
Mar. 3, 1879 June 14, 1880	George C. Fobes & Co	12.3	1,610,804	Feb. 19, 1881	Nov. 9, 1882
Mar. 3, 1881	G. L. Long	11.7	724,730	Mar. 21, 1882	Jan. 24, 1884
Aug. 2, 1882	R. Moore	12.3	888,093	Jan. 24, 1883	Feb. 9, 1884
July 4, 1884	Tobias Burke	9	1,920,438	Sept. 19, 1884	June 15, 1886
Aug. 6, 1886	R. Moore	9.5	829,854	Oct. 2, 1886	Apr. 25, 1887
Total			5,973,919		

The progress of the improvement of the channel from Mobile to the anchorage in the lower bay during the fiscal year ending June 30, 1887, was as follows:

Total number cubic yards of material removed, 829,854.

Cut No. 4 was dredged from a point 140 feet south of Cluster No. 4, to a point 140 feet north of Cluster No. 23, a distance of 49,995 feet, and from a point opposite Cluster No. 27 to Cluster No. 30, 7,799 feet.

The lower turn on Fowl River Reef was widened for a length of 1,750 feet and with a central width of 315 feet, facilitating the navigation of the channel at that point.

Tabular statement of condition of the improvement of Mobile Harbor, Alabama.

[Project: 17 feet dredged channel at mean low tide, June 30, 1887.]

Locality.	Dredged, 1881-'87.				Examination, 1886-'87.	
	From the initial point.	Length between clusters.	Width.	Depth.	Minimum top width.	Maximum central depth.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Initial point at mouth of Mobile River, or Chain Cluster No. 1			145	19-20	200	20.4
From Chain Cluster No. 1 to Chain Cluster No. 2	0.06	330	145	19-20	200	19.8
From Chain Cluster No. 2 to Upper Gap Light Stake.	0.45	2,080	145	18-19	200	20.7
Upper Gap Light Stake to Cluster No. 2	0.64	978	245	18-19	300	22
Cluster No. 2 to Chain Cluster No. 3, middle ground between Mobile and Spanish rivers	1.07	2,259	155	18-19	190	20.1
Chain Cluster No. 3 to Lower Gap Light Stake	1.48	2,182	155	18-19	190	20.9
Lower Gap Light Stake to Cluster No. 3	1.96	2,565	145	18-19	180	19.7
Cluster No. 3 to Cluster No. 4	2.46	2,603	145	18-19	180	20.5
Cluster No. 4 to Cluster No. 5, Dog River Bar	3.25	4,194	145	18-19	180	19.5
Cluster No. 5 to Cluster No. 6, Dog River Bar	3.50	1,338	145	18-19	180	20.6
Cluster No. 6 to Cluster No. 7	4.02	2,735	145	18-19	180	18.9
Cluster No. 7 to Cluster No. 8	4.59	2,998	145	18-19	180	19.6
Cluster No. 8 to Cluster No. 9	5.09	2,654	145	18-19	180	20.5
Cluster No. 9 to Cluster No. 10	5.61	2,713	145	18-19	180	20
Cluster No. 10 to Cluster No. 11	6.11	2,655	145	18-19	180	20.1
Cluster No. 11 to Cluster No. 12	6.60	2,610	145	18-19	180	18
Cluster No. 12 to Cluster No. 13	7.08	2,501	145	18-19	180	18.4
Cluster No. 13 to Cluster No. 14	7.54	2,418	145	18-19	180	18.6
Cluster No. 14 to Cluster No. 15	8.03	2,625	145	18-19	180	18.9
Cluster No. 15 to Cluster No. 16	8.54	2,666	145	18-19	180	18.1
Cluster No. 16 to Cluster No. 17	9.03	2,591	145	18-19	180	18
Cluster No. 17 to Cluster No. 18	9.52	2,582	145	18-19	180	19.5
Cluster No. 18 to Cluster No. 19	10.01	2,616	145	18-19	180	19
Cluster No. 19 to Cluster No. 20	10.52	2,659	145	18-19	180	19
Cluster No. 20 to Cluster No. 21	11.00	2,580	145	18-19	180	18.6
Cluster No. 21 to Cluster No. 22	11.41	2,550	145	18-19	180	19.8
Cluster No. 22 to Cluster No. 23	11.99	2,590	145	18-19	180	18.8

Tabular statement of condition of the improvement of Mobile Harbor, Alabama—Cont'd.

Locality.	Dredged, 1881–'87.				Examination, 1886–'87.	
	From the initial point.	Length between clusters.	Width.	Depth.	Minimum top width.	Maximum central depth.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cluster No. 23 to Cluster No. 24	12.45	2,502	105	18–19	140	15.8
Cluster No. 24 to Cluster No. 25	12.94	2,560	105	18–19	140	16.3
Cluster No. 25 to Cluster No. 26	13.42	2,535	105	18–19	140	16.3
Cluster No. 26 to Cluster No. 27	13.91	2,592	105	18–19	140	16.8
Cluster No. 27 to Cluster No. 28	14.40	2,592	145	18–19	180	16.7
Cluster No. 28 to Cluster No. 29, Fowl River Reefs	14.99	2,587	145	18–19	180	17.2
Cluster No. 29 to Cluster No. 30, Fowl River Reefs.	15.39	2,620	145	18–19	180	16.5
Cluster No. 30 to Cluster No. 31, Fowl River Reefs lower turn L. H	15.91	1,790	185	18–19	200	22.6
Cluster No. 31 to Cluster No. 32, Fowl River Reefs.	16.21	2,580	185	18–19	200	16.7
Cluster No. 32 to Cluster No. 33	16.71	2,650	185	18–19	200	15.7
Cluster No. 33 to Cluster No. 34	17.24	2,750	185	18–19	200	15.2
Cluster No. 34 to Cluster No. 35	17.75	2,725	185	18–19	200	14.6
Cluster No. 35 to Cluster No. 36	18.27	2,750	185	18–19	200	15.4
Cluster No. 36 to Cluster No. 37	18.77	2,615	185	18–19	200	14.8
Cluster No. 37 to Cluster No. 38	19.25	2,540	185	18–19	200	15.2
Cluster No. 38 to Cluster No. 39	19.76	2,695	185	18–19	200	15.4
Cluster No. 39 to Cluster No. 40	20.27	2,705	185	18–19	200	15.5
Cluster No. 40 to Cluster No. 41	20.60	2,227	185	18–19	200	15.3
Cluster No. 41 to Cluster No. 42	21.29	3,160	185	18–19	200	15.3
Cluster No. 42 to Cluster No. 43	21.83	2,824	185	18–19	200	15.2
Cluster No. 43 to Cluster No. 44	22.33	2,660	185	18–19	200	15.3
Cluster No. 44 to Cluster No. 45	22.94	3,230	185	18–19	200	15.6
Cluster No. 45 to Cluster No. 46	28.35	2,145	185	18–19	200	15.7
Cluster No. 46 to Cluster No. 47	23.89	2,865	185	18–19	200	16.5
Cluster No. 47 to Cluster No. 48	24.40	2,701	185	18–19	200	17
Cluster No. 48 to Cluster No. 49	24.94	2,838	185	18–19	200	16.7
Cluster No. 49 to Cluster No. 50	25.49	2,930	185	18–19	200	17.6
Cluster No. 50 to Cluster No. 51, Dumb beacon 17 feet curve	25.91	2,210	185	18–19	200	17.4

The condition of the channel previous to the commencement of the present project was such that no vessel of greater draught than 12 feet could come to the city, but all such anchored in the lower bay, a distance of 28½ miles, and the cargoes were lightered or rafted to and from the city at a great expense and frequently at considerable loss of cargo and time.

The channel of 17 feet depth with a width of 175 feet was opened in 1882, and during the business season of 1882 and 1883 all vessels entering the bay came up to the wharves of the port and there discharged cargoes or ballast, then reloaded with full cargoes, or to a depth of 16½ feet and in some cases to 17 feet and 17½ feet, but owing to the vessels getting out on the slopes of the channel, thereby pressing material into the dredged channel and also causing delay to other vessels, it was deemed best to limit the draught to 16 feet until the channel was widened; the average draught, therefore, during 1883, 1884, and 1885 was 15½ feet. The width being increased during the fiscal year ending June 30, 1887, the draught of all vessels loaded at the wharves was between 15½ and 17 feet, the average being 16 feet, and in all cases passing through the channel without delay.

The following is a statement of the number and character of vessels of greater draught than 13 feet that have passed through the 17-foot channel without any material delay during the fiscal year ending June 30, 1887:

Draught.	Steamers.		Ships.		Barks.		Brigs.		Schooners.		Total.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
13 to 14 feet	4	....	2	....	3	6	....	....	4	16	13	22
14 to 15 feet	5	1	2	1	....	6	1	....	3	24	11	32
15 to 16 feet	4	6	1	5	1	35	....	1	5	1	11	48
16 to 17 feet	..	10	..	4	2	19	....	....	1	1	3	34
17 to 17½ feet	...	1	....	....	....	1	...	....	....	....	....	2
17½ to 18 feet	...	....	....	....	.	......	...	.. ....	....	.... ..	.	....
Total	13	18	5	10	6	67	1	1	13	42	38	138

1881-'82.	No.	1879-'80.	No.
13-foot draught vessels up and down	48	13-foot draught vessels up and down	25
13½-foot draught vessels up and down	19	13½-foot draught vessels up and down	4
14-foot draught vessels up and down	3	Total	29
14½-foot draught vessels up and down	1		
Total	71		

NOTE.—On Tuesday, July 6, 1887, the American bark *Chalmette*, with 800 tons of steel rails, drawing 17.6 feet on even keel, equivalent to about 18.5 feet depth with a drag of five-tenths, ascended the dredged channel without delay and discharged her cargo at the Conti street wharf.

Since the commencement of the work, or from 1881 to 1887, there has been a refilling above the 17-foot line, principally from the sloping of the banks of the cut, of about 1,300,000 cubic yards, or at the rate of about 216,660 cubic yards per year.

There remains to complete the project the removal of about 700,000 cubic yards, at a cost of about $84,000.

There will be required for the preservation of the improvement a yearly appropriation of about $25,000 for several years, or until the banks have assumed a permanent slope.

The present channel has been found altogether too narrow and should be widened at least 100 feet, which will require the removal of 3,000,000 cubic yards at a cost of about $360,000.

Money statement.

July 1, 1886, amount available	$912.78
Amount appropriated by act approved August 5, 1886	90,000.00
	90,912.78
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	88,473.88
July 1, 1887, amount available	2,438.00
Amount (estimated) required for completion of existing project	84,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	444,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids received in response to advertisement dated September 3, 1886, *and opened September* 18, 1886.

No.	Names and residences of bidders.	Price per cubic yard.	Time of commencement.	Time of completion.
		Cents.		
1	Peter Burke, Mobile, Ala	11$\frac{4}{10}$	In accordance with specifications.	In accordance with specifications.
2	George C. Fobes & Co., Baltimore, Md.	10	......do	......do
3	Rittenhouse Moore, Mobile, Ala.	9½	......do	......do
4	John Maguire, Mobile, Ala	11⅜	......do	......do
5	S. N. Kimball, Apalachicola, Fla.	15	......do	......do

COMMERCIAL STATISTICS.

The following statistical statement for the years 1886–'87 was furnished by the collector of customs of this port.

Description.	Entrances June 30, 1887.			Entrances June 30, 1886.			Clearances June 30, 1887.			Clearances June 30, 1886.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Foreign	78	47,723	1,014	109	75,003	1,468	86	54,764	1,131	121	83,947	1,670
Coastwise	84	39,708	871	54	24,509	507	73	31,706	714	45	16,316	346
American	24	7,771	179	34	8,172	252	31	9,701	241	46	12,571	353
Total	186	95,202	2,064	197	107,684	2,227	190	96,171	2,086	212	112,834	2,371

IMPORTS AND EXPORTS.

Description.	1887.	1886.
Duties on imports	$19,042.32	$18,819.23
Tonnage dues	2,549.70	4,242.42
Hospital collections	408.00	787.07
Miscellaneous	750.78	2,884.93
Total collections	22,750.80	26,733.64
Exports to foreign ports	2,557,854.00	2,748,811.00
Imports of foreign goods, values:		
Free	32,725.00	....
Dutiable	31,811.00	....

Number of vessels entering and clearing at Mobile, Ala.

Description.	In port June 30.	Tonnage.	Cleared.	Tonnage.	Cargoes.				Ballast.			
					Foreign.		Coastwise.		Foreign.		Coastwise.	
					In.	Out.	In.	Out.	In.	Out.	In.	Out.
1881–'82.												
Steam-ships	......	....	3	1,514	1	3	......	......	1	......	1	......
Ships	......	....	18	14,802	1	12	1	......	10	......	1	1
Barks	9	3,632	78	51,642	4	63	5	6	64	......	4	9
Brigs	......	....	23	6,127	4	10	7	13	3	......	9	......
Schooners	8	327	109	22,675	24	50	17	53	9	1	67	5
Total	17	3,959	226	96,760	34	138	30	72	87	1	82	15
1885–'86.												
Steam-ships	1	757	18	8,354	1	6	7	11	6	.....	5	1
Ships	1	911	19	21,440	1	18	......	......	19	1	......	......
Barks	3	1,712	95	62,742	5	89	3	4	83	1	4	1
Brigs	......	....	7	2,452	1	5	2	1	4	......	......	1
Schooners	3	451	147	30,709	29	54	66	75	17	4	24	14
Total	8	3,831	286	125,697	37	172	78	91	129	6	33	17
1886–'87.												
Steam-ships	......	....	20	15,313	3	9	13	11	4	......	1	......
Ships	......	....	9	10,235	3	8	......	......	5	......	1	1
Barks	......	....	61	40,897	2	54	4	3	45	......	9	4
Brigs	......	....	1	397	......	......	1	1	......	......	......	......
Schooners	......	....	99	29,329	24	46	37	48	16	......	18	5
Total	......	....	190	96,171	32	117	55	63	70	......	29	10

Comparative statement of timber, lumber, etc., shipped by vessel to foreign and coastwise ports.

Description.	1887.		1886.		1881.
	Quantity.	Value.	Quantity.	Value.	Quantity.
Lumber:					
Foreign ......feet, B. M..	12,139,000	$134,966	18,628,549	$209,278	11,531,251
Coastwise ......do....	14,047,000	154,517	5,835,914	70,030	9,587,562
Total ......do....	26,186,000	289,483	24,464,463	279,308	21,188,808
Timber:					
Foreign ......feet, B. M..	21,650,000	210,396	36,416,664	339,878	20,326,056
Coastwise ......do....	661,000	7,932	385,451	3,212	131,832
Total ......do....	22,311,000	218,328	36,802,115	343,090	20,457,888
Shingles:					
Foreign ......number..	314,000	1,467	494,950	2,233	3,900,000
Coastwise ......do....	2,036,000	20,180	685,000	3,425	2,160,000
Total ......do....	2,350,000	21,647	1,179,950	5,658	6,060,000
Staves:					
Foreign ......number..	43,000	4,697	92,469	10,468	91,462
Coastwise ......do ...	1,078,000	97,020	234,216	26,024	....
Total ......do....	1,111,000	101,717	326,685	36,492	91,462

THE EFFECT UPON THE RATES OF FREIGHT AND INSURANCE.

Freight.—The transportation of cotton by lighters to the lower fleet being avoided, a saving of 10 cents per bale is thus made, equalizing port charges with New Orleans and other favored harbors.

By this increased facility the competing routes of transportation have lowered freight to Liverpool and other cotton marts one-fourth cent per pound.

The immediate benefits to commerce are the following:

(1) No detention in handling freight.

(2) No risk entailed, as formerly, as cotton often reached the lower fleet in a wet condition, and otherwise damaged.

(3) The expenses attending the loading of vessels are greatly reduced, stevedores and others storing cotton not to be cared for; this amounting to a saving of from $50 to $100 per vessel, according to tonnage and smoothness of the bay.

The prospective advantages to commerce, etc., are many, chiefly the transportation of grain in bulk and the possibility of erecting elevators for the rapid handling of articles of commerce from the Northwest.

The establishment of lines of steamers, coastwise, Atlantic, and Europe, two lines already being operated successfully.

Q 2.

IMPROVEMENT OF BLACK WARRIOR RIVER, ALABAMA, FROM TUSCALOOSA TO DANIELS CREEK.

The survey of the Black Warrior River, from Tuscaloosa to Sipsey Fork, was made in the fall of 1879, in compliance with the provisions of the act of Congress approved March 3, 1879.

The report is contained in Report of Chief of Engineers, 1881, Part II, page 1218.

Based upon this survey, the following appropriations have been made:

By act July 5, 1884	$50,000
By act August 5, 1886	56,250
Total	106,250

Under the first of these appropriations a survey for the purpose of locating locks and dams and to furnish data for the preparation of detailed plans and estimates was commenced in September, 1884, and a report providing for a system of locks and movable dams, with plans and estimates for their construction, was submitted December 19, 1885.

A Board of Engineer officers met in Tuscaloosa, Ala., February 10, 1886, to consider and report upon the project submitted.

The Board did not approve the method proposed, but instead recommended the improvement to be prosecuted under ordinary slack-water system, with locks and fixed dams.

Plans and estimates for the project as recommended were submitted August 13, 1886, and with certain modifications were accepted by the Board of Engineers in their report, dated April 2, 1887.

The estimated cost was $566,104. This estimate was, however, considered too low by the Board, and is to be revised.

The extent of the work is the construction of five locks with fixed dams from Tuscaloosa to Daniels Creek, a distance of 14¾ miles.

The project adopted is to afford a water-way for transportation of coal in barges from the Warrior coal-fields by a slackwater system of locks and fixed dams.

The above project was approved May 19, 1887, with the stipulation "that no work was to be undertaken upon any portion of the improvement where the purchase of land for sites, etc., would be required," and instructions were issued to ascertain the quantity "of land that would be required for the lock and dam-sites, and other purposes of the work, and to submit report of the same with maps of the same, showing by metes and bounds the precise location of such lands, together with an estimate of their probable cost, so that the subject might be presented to Congress, at its next session, for the desired legislation."

The investigation of titles to the land required for sites for Lock No. 1 and lock-tender's house (to be used as an Engineer office) was made during the month of June, and survey to locate these sites commenced. This constituted the work during the fiscal year ending June 30, 1887.

The river is at present navigable at high water only, and even then sufficiently dangerous to put a stop to all commerce on the river, although barges have been frequently floated down to Mobile loaded with coal.

It is proposed to apply the funds available during fiscal year ending June 30, 1888—

(1) To removing the reef below Lock No. 1, or so much of it as may be necessary for destroying the 3½-foot fall under the bridge, the immediate object in view being to uncover the site for Lock No. 1.

(2) To build a lock-tender's house of wood, on brick or stone foundation, to serve as engineer's office and store-room in the prosecution of the work.

(3) To construct lock-walls, lock-gates, dam-abutments, and dam of Lock No. 1, according to the approved plans, or to execute as much of the above work as the amount available will permit.

The enormous quantity of coal in the country through which this river flows, and its excellent quality and accessibility, prove conclusively the importance of the early completion of this improvement, rendering it available for the use of the General Government, the people of the Gulf States, and the steamers of all nations employed in the commerce of the Gulf.

Money statement.

July 1, 1886, amount available	$46,102.04
Amount appropriated by act approved August 5, 1886	56,250.00
	102,352.04
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,252.06
July 1, 1887, amount available	101,099.98
Amount (estimated) required for completion of existing project, subject to revision	463,854.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	200,000.00
Submitted in compliance with requirements of sections 2 river and harbor acts of 1866 and 1867.	

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C. April 15, 1887.

SIR: I have the honor to submit herewith a report, dated April 2, from the Board of Engineers constituted to consider the subject of the improvement of Black Warrior River, Alabama, from Tuscaloosa to Daniel's Creek, for which appropriation is made in the river and harbor act of August 5, 1886.

The project proposed for the improvement of this part of the Upper Warrior contemplates a slackwater system of locks and dams for a distance of 15 miles between these two points.

The plans submitted by Major Damrell in 1885 have been under consideration by a Board of Engineers constituted January, 1886, and reconvened December 22, 1886, which, in its first report, advised against the adoption of the plan of movable dams proposed by that officer, and recommended that new plans be prepared by him, with the view to an improvement by fixed dams, in accordance with the type in general use on western rivers. It is upon plans modified to comply with this recommendation that the report herewith submitted has reference. They contemplate the construction of five locks and dams, at a cost, estimated by Major Damrell, of $566,000, including accessories.

The Board, after very careful and complete investigation, approves the plans submitted to it, but recommend a number of minor changes, which are given in detail, and, being of opinion that the estimates of Major Damrell are manifestly too low, further recommend that new estimates be made, in view, as well, of the changes proposed; but for the reason of the importance of having the work commenced during the coming season, the Board suggests that it be begun without waiting for a revision of the estimates.

In view of, as will be perceived, the very careful investigations made by the Board in its discussion of all the details of the proposed improvement, its conclusions are recommended for approval.

This being a new work, it is further recommended that authority be given to instruct Major Damrell to proceed with the construction of the lock-walls and the dam of Lock No. 1, in accordance with the plan as advised by the Board; and also of a lock-house, to serve as an engineer office in the further prosecution of the work.

The amount available for this improvement is at present $56,250 of the appropriation of August 5, 1886, and about $46,000 remaining on hand from the appropriation of July 5, 1884—in all, about $102,250.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT,
April 19, 1887.

The recommendations of the Chief of Engineers are approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

LETTER TRANSMITTING REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., April 2, 1887.

GENERAL: I have the honor to forward herewith the report of the Board of Engineers convened by your orders to consider the subject of the improvement of the Black Warrior River, Alabama, near Tuscaloosa, dated April 2, 1887.

In a separate package are sent two tables of the heights of the water at the several dams on the Kentucky River, during the rises extending from February 19 to March 7, and from March 20 to April 26, 1886, and two sheets of hydrographs representing the same. These papers illustrate the report and should be printed with it.

In view of possible objection to photolithographing these hydrographs on the profile paper on which they have been drawn, a specimen print of a photograph of one of the original sheets is sent herewith for examination. The green lines, it will be observed, are dark enough to form a scale for the curves.

The Board met in New York in the latter part of December, and was in session two days. After full discussion it was agreed that after further study by a committee consisting of the members stationed in Cincinnati, Colonel Merrill and Major Post, the report should be prepared there and sent to the other members for consideration. This course has been pursued.

Much study has been given by the committee, and the report is the result of their labor, with some modifications suggested by Major King.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF BOARD OF ENGINEERS.

APRIL 2, 1887.

SIR: The Board of Engineers convened by Special Orders No. 9, dated Headquarters Corps of Engineers, January 25, 1886, to consider and report upon the project submitted by Major Damrell for the improvement of the Black Warrior River, Alabama, and reconvened by Special Orders No. 201, dated Headquarters Corps of Engineers, December 28, 1886, would respectfully submit the following report:

In their first report the Board advised against the adoption of the plan of movable dams submitted by Major Damrell, and recommended that new plans be prepared with a view to the improvement of the Black Warrior River by fixed dams in accordance with the type in general use on western rivers. The reassembling of the Board was for the purpose of examining and reporting upon the plan for improving this river, as modified to comply with this recommendation.

Pursuant to the call of the senior member the Board met at the Army Building in New York, on the 29th of December, and carefully examined the plans and drawings submitted by Major Damrell. They approve of these plans in general, but recommend a number of minor changes which will now be given in detail.

LOCATION OF DAMS.

These are approved, with the following exceptions: Dam No. 3 should be moved up-stream so as to rest against the buttress of the upper lock-gate; Dam No. 4 should be built according to location A, and slightly turned so as to be normal to the axis of the river; and Dam No. 5 should be made normal to the axis of the river.

LOCATION OF LOCKS.

Lock No. 1 should be moved down-stream until the upper gate buttress comes to the end of the dam, and it should be built as far into the bank as practicable. Lock No. 2 should be built further into the bank, and should be moved down-stream as far as the site will permit. If this change does not bring the upper buttress to the end of the dam, as now designed, then the dam should be moved up-stream until this condition is obtained. Lock No. 4 should be moved down-stream until the upper buttress comes to the end of the dam. Lock No. 5 should be similarly moved down-stream.

GUIDE-CRIBS.

At the head of the river wall of each lock there should be a guide-crib as high as the lock-wall, filled with stone. This crib should at first be about 100 feet long, the length to be increased should future experience prove it to be necessary. This crib-work should have a short head, built 5 feet higher than the body of the crib, and sloping up-stream, in order to receive the shock of floating bodies. The lower course of the crib-work may connect with the river wall, but the two should be separated at the top by a gap for drift, having a width of 10 feet, and a depth below pool level of at least 6 feet.

ABUTMENTS.

The abutments are all too low. They should be carried up vertically to a height at least 5 feet greater than that of the lock-walls, and they should be set so far into the bank as not to act as jetties or spurs during floods. The height named is a preliminary one, and experience may show a necessity for adding to it in the future. The masonry work should be extended down-stream to a distance of at least 60 feet below the lower side of the dam, but the top need not be carried to full height beyond a point half-way between the crest and the foot of the dam. Beyond this it can descend rapidly in steps to a height of from 4 to 8 feet above the low-water line below the dam, depending on the lift. The abutment (except where the natural bank is of rock, as at No. 4) should be prolonged down-stream a further distance of about 100 feet, by means of a crib-work built up to the height of the lowest step of the masonry abutment. The length and height of this crib extension are to be considered as approximate, subject to such modifications as future experience may indicate. As the abutments are all to be built on bed-rock, it will not be necessary to have any crib-work on their river sides, and those shown on the drawings should be omitted. The natural bank behind the abutment should be graded, and paved to the top with 12-inch paving for a width of at least 50 feet.

DETAILS OF LOCK.

The *size of the locks* as shown in the drawings is 300 feet between hollow quoins, and 52 feet wide. The "available length," which is the length that can be utilized by boats, is the distance between the upper end of the lower gate recess and the chord of the upper miter wall. This distance in the drawings is 258 feet, which will suffice for a barge 130 feet long and a tow-boat 128 feet long. Such a tow-boat will hardly have sufficient power, and the Board would recommend that the available length be increased 22 feet, so as to admit a tow-boat with a length over all of 150 feet. A still greater increase would be desirable, but it would add so much to the cost of construction, and can so easily be made hereafter, should circumstances demand it, that the Board think it advisable to restrict present work to the limits stated above. The *river wall abreast of the chamber* should not exceed 7 feet in width on top, and the land wall should be as strong as the river wall, but its coping may be made narrow. The *river side of the river wall* has too many sharp angles. These should be eased off by curves, and by lessening the widths and increasing the lengths of the buttresses. The *method of handling the gate* is considered objectionable where power is not used. It is recommended that the gates be handled by capstan and spar. *Diagonal anchor rods* have been tried by members of the Board, and are considered objectionable on account of the difficulty of attaching the straps and the inconvenience in construction. It is better to use vertical anchor rods. Tie *rods shown in the masonry* are unnecessary, and should be omitted. The *lower wing wall* should be moved down to the end of the lock. The *chamber walls* should be built of rough-pointed masonry, without pilasters. Owing to the change in direction of the pressures on the lock walls, caused by the change in the relative positions of the dams, it is advisable that the *profiles of these walls* be recalculated to meet the new conditions. *Recessed ladders* should be placed in the chamber walls. *Mooring rings* on top of the walls should be replaced by solid iron bolts, or snubbing posts of either wood or iron. A low *guard-timber* of rounded oak should be placed along the inner edges of the chamber walls for the protection of steam-boat lines. The *movable dam* at the lower end of the lock should be omitted. The *filling and emptying culverts* are too small to serve the lock with the desired rapidity. The *proposed valve* for closing the culverts is not considered equal to some other styles, and additional study on this point is recommended. *Gratings* should be placed in front of the valve-openings in order to exclude drift, and due allowance should be made for the space occupied by the rods. The *upper miter* wall should be placed one course lower than would otherwise be necessary, in order to maintain the standard depth of water in case the pool should be lower than the crest of the dam, and also in order to permit the pool to be drawn down whenever it is necessary to repair the upper slope of the dam. The *filling culvert of the river wall* should draw water from the upper gate recess in order to keep this recess from being filled with mud and drift. The proposition to build *iron lock gates* is approved for the first lock to be completed, leaving the question as to the other locks to be determined by the more abundant experience on other rivers, that will be available before these locks are built. The climate is undoubtedly unfavorable to the durability of wooden lock gates. The *tops of lock gates* should be flush with the tops of the lock walls. A *drainage culvert*, with open joints, carefully sealed from the upper pool, should be placed behind the land wall.

DETAILS OF DAMS.

The Board doubt whether the method proposed for building the dams would be successful on account of the probable inequality of settlement, that would break the bond of the masonry and the union of the masses, and dangerously weaken the structure. For this reason, and as a measure of economy, they recommend that the dams be built of timber with stone filling, following the types used on either the Monongahela or the Kentucky rivers, as the engineer in charge may elect. The downstream slope should not be steeper than one on four, if a slope dam be built, or one on three with a step dam. If the latter style be adopted, the steps should increase in height from the crest downwards. The crests of dams should be placed at normal pool level, and not 6 inches lower as proposed.

LIFTS OF THE DAMS.

It is very important that the lifts of the dams should be so regulated that in time of flood the dams will be drowned out in regular succession, beginning at the foot of the rapids. The heavy grades of the bed, the great variations in width of river, and the effects of backwater from the natural channel below Tuscaloosa, make the problem a complicated one, and as the investigations of the Board have caused the compilation of valuable and interesting data from the five locks and dams on the Kentucky River, which have not hitherto been published, it has been deemed best to discuss this question of lift in unusual detail.

The basis of our investigations is the following table of maximum discharges of the Black Warrior River at Tuscaloosa, which has been prepared by Mr. Harding, assistant engineer, from observations made at various stages, and afterwards modified so as to correspond as nearly as possible to maximum discharges.

Maximum discharges of Black Warrior River at Tuskaloosa, Alabama, referred to gauge at landing.

Gauge reading.	Discharge.	Gauge reading.	Discharge.	Gauge reading.	Discharge.	Gauge reading.	Discharge.	Guage reading.	Discharge.
	Cu. feet.		*Cu. feet.*		*Cu. feet.*		*Cu. feet.*		*Cu. feet.*
105	3,200	114	12,040	123	25,900	132	45,438	141	70,277
106	3,800	115	13,500	124	27,720	133	47,865	142	73,570
107	4,500	116	14,860	125	29,600	134	50,351	143	76,996
108	5,300	117	16,270	126	31,620	135	52,913	144	80,559
109	6,200	118	17,730	127	33,720	136	55,558	145	84,265
110	7,200	119	19,250	128	35,900	137	58,293	146	88,000
111	8,200	120	20,800	129	38,160	138	61,125	147	91,500
112	9,420	121	22,440	130	40,743	139	64,062	148	95,000
113	10,680	122	24,140	131	43,068	140	67,110	149	99,000

The formula to be used will be that of Weisbach, taken from Vol. II, page 109, of his Mechanics of Engineering.

It reads as follows:

$$(1)\qquad Q = mb\sqrt{2g}\left\{ \tfrac{2}{3}\left[(h_1+k)^{\frac{3}{2}} - k^{\frac{3}{2}}\right] + (h-h_1)\,(h_1+k)^{\frac{1}{2}} \right\}$$

In which:

m is a constant, given by Weisbach as 0.8;
b is the length of the overfall;
g is the force of the gravity$=32.16$;
h is the depth of headwater on the dam;
h_1 is the fall at the dam; and
k is the height due to the velocity of approach.

Reverse and reduce the equation and we have:

$$(2)\qquad (h_1+k)^{\frac{3}{2}} - k^{\frac{3}{2}} + \tfrac{3}{2}(h-h_1)(h_1+k)^{\frac{1}{2}} = \frac{3Q}{2mb\sqrt{2g}} = \frac{Q}{4.2773\times b}$$

Which is the general equation that will be used in the calculations that follow.

If we neglect the velocity of approach the equation takes this form:

$$(3)\qquad h_1^{\frac{3}{2}} + \tfrac{3}{2}(h-h_1)\,h_1^{\frac{1}{2}} = \frac{Q}{4.2773\times b}$$

In this formula $h-h_1$ is the backwater on the dam from the dam next below or from the open river, and is independent of the dimensions or the local conditions of the dam to be built. This formula enables us to determine what will be the fall over the new dam corresponding to any stage of the river whose discharge is Q. It is evident, however, that we are only concerned with high stages of the river, at which times the numerator of the fraction forming the second member is much greater than the denominator, and the second member of the equation is a positive whole number. It is also evident that as we increase b we diminish the second member, and hence the value of the fall over a dam for a given discharge in high stages varies inversely with the length of the spill. It is therefore advisable to make the length of the dam as great as circumstances will permit.

Let us now determine what will be the fall over Dam No. 1 when the Tuskaloosa gauge stands at 123.00 corresponding to a maximum discharge of 25,900 cubic feet. As the crest of the dam has been placed at reference 114.00 there is evidently 9 feet of backwater on the dam. The length of the spill has been taken at 325 feet; this is more than is shown on the drawings, because the Board have recommended that the spill at Dam No. 1 be lengthened by placing the lock further in the banks. A similar change has been recommended at Dam No. 2, and a similar discrepancy will appear in the length of this dam.

In discussing Dam No. 1, we have the following constants in equations (3):

$$h-h_1=9 \qquad Q=25900 \qquad b=325$$

Substituting these we get:

$$(4)\qquad h_1^{\frac{3}{2}}+13.5\,h_1^{\frac{1}{2}} = \frac{25900}{4.2773\times 325} = 18.63145$$

Solving this cubic equation we find:

$$h_1 = 1.5355$$

If therefore we ignore the velocity of approach, the water surface above Dam No. 1 will be at the reference 124.55, and the fall over the dam will be about 1½ feet.

Let us see how these results would be affected by taking into account the velocity of approach.

The cross-section of the river above the dam may be considered as equal to the space occupied by the dam itself, increased by that occupied by the water that flows over it.

Calling the velocity of approach V', and the height of the dam d_1 we have:

$$V' = \frac{Q}{b\,(h+d)} \tag{5}$$

but

$$K = \frac{V'^2}{2g} = \frac{V'^2}{64.34}$$

Hence

$$K = \frac{Q^2}{64.34 \times b^2 \times (h+d)^2} \tag{6}$$

In the case in question the dam is 14 feet high, with its crest at the reference 114.00; the length of the spill is 325 feet; the discharge is 25,900 cubic feet; and the gauge-reading is 123.00. As the fall has just been found to be 1.55 feet, the upper pool must stand at the reference 124.55, and the depth of water on the dam must be 10.55 feet.

Substituting the value of the constants in equation (6) we have:

$$K = \frac{(25900)^2}{64.34 \times (325)^2 \times (10.55 + 14)^2}$$

Whence:

$$K = 0.16377$$

and:

$$K^{\frac{3}{2}} = 0.06628$$

Substituting in equation (2) the values of k, just found, and those of the other constants, and transferring $k^{\frac{3}{2}}$ to the second member, we have:

$$(h_1' + 0.1638)^{\frac{3}{2}} + 13.5\,(h_1' + 0.1638)^{\frac{1}{2}} = 18.6315 + 0.0663 = 18.6978 \tag{7}$$

Comparing this with (4) we find that the second member of the equation has not been sensibly changed, and that the first member is exactly the same, except that h_1' 0.1638 has taken the place of h_1. We may therefore assume without appreciable error that:

$$h_1' + 0.1638 = h_1$$

Which is equivalent to saying that the true value of the fall may be obtained from the approximate value, as determined by neglecting the velocity of approach, by subtracting from the latter the value of *k*. Hence, in the case in hand, the true value of the fall over the dam is 1.3835 feet, or 16½ inches.

Repeating the calculations for various stages, we obtain the following table:

DAM No. 1.

[Lift 14 feet.]

Gauge-reading at landing.	Fall over dam without velocity of approach.	Height due to velocity of approach.	Fall corrected for velocity of approach.	Level of upper pool.	Guard required.	Total height of lock-walls.
123.00	1.55	0.16	1.39	124.39	10.39	24.39
124.00	1.47	0.17	1.30	125.30	11.30	25.30
125.00	1.41	0.18	1.23	126.23	12.23	26.23
126.00	1.38	0.20	1.18	127.18	13.18	27.18
127.00	1.35	0.21	1.14	128.14	14.14	28.14

It is advisable to give Dam No. 1 as great a lift as possible, on account of the rapids above it, but in view of the fact that we still have a fall of over a foot, with lock-walls over 27 feet high, and the further fact that any increase in lift would increase the fall over the dam, the height of the dam has been fixed at 14 feet.

If possible, the lock-walls should have such a height that boats can pass through the lock whenever they cannot run over the dam, but it is manifest that economical considerations limit the attainable height. In the case in question it has been thought best to limit the height of the lock-walls to 27 feet.

Let us now take up Dam No. 2, and assume the proposed lift of 8 feet. As the lock is to be moved into the bank, we will have a length of spill of 410 feet. Mr. Harding's gauge records show that when the lower gauge reads between 136.00 and 140.00, the surface slope of the natural river is 1 foot per mile. This slope will be used in obtaining backwater on Dam No. 2, and such results as require particular accuracy will afterwards be re-examined, in order to ascertain the effect, if any, of backwater from Dam No. 1.

Calculating on this basis we have the following table:

DAM No. 2.

[Lift 8 feet.]

Gauge reading at landing.	Assumed level of backwater.	Fall over dam without velocity of approach.	Height due to velocity of approach.	Fall corrected for velocity of approach.	Level of upper pool.	Guard required.	Height of lock-walls.
133.00	134.00	1.88	0.29	1.59	135.59	13.59	26.59
134.00	135.00	1.81	0.30	1.51	136.51	14.51	27.51
135.00	136.00	1.75	0.31	1.44	137.44	15.44	28.44
136.00	137.00	1.71	0.32	1.39	138.39	16.39	29.39
137.00	138.00	1.67	0.33	1.34	139.34	17.34	30.34
138.00	139.00	1.65	0.34	1.31	140.31	18.31	31.31
139.00	140.00	1.63	0.36	1.27	141.27	19.27	32.27
140.00	141.00	1.61	0.37	1.24	142.24	20.24	33.24

If we limit the height of lock-walls to 27 feet it is evident that the lock will cease to be available for navigation when the gauge stands at 133.50, at which time the fall over the dam will be about 1.55 feet.

This condition of affairs is evidently less favorable than that which prevails at Dam No. 1, when that lock ceases to be available. The only way in which this can be remedied is to reduce the lift of Dam No. 2. Let us then reduce the lift and compare the results with those just obtained.

DAM No. 2.

Lift.	Gauge reading.	Assumed level of back-water.	Fall over dam without velocity of approach.	Height due to velocity of approach.	Fall corrected for velocity of approach.	Level of upper pool.	Guard required.	Height of lock-wall.
7.00	134.00	135.00	1.61	0.32	1.29	136.29	15.29	27.29
7.05	134.00	135.00	1.71	0.31	1.40	136.40	14.90	27.40
8.00	134.00	135.00	1.81	0.30	1.51	136.51	14.51	27.51

The height of the lock-walls is obtained by subtracting the level of the bed of the river, 109.00 from the level of the upper pool.

Let us now see how the backwater on Dam 2 will be affected by Dam No. 1 when the gauge reads 134.00.

As the lock at Dam No. 1 will be submerged at this stage, it is first necessary to see how formula (1) must be modified, in order to take into account the discharge over the lock.

Let

Q' = the discharge over the dam.
Q'' = the discharge over the lock.
h'' = depth of water on the lock.
b'' = length of overfall on lock.

Recollecting that h_1 and k are the same in both, we have:

$$(13) \qquad Q' = mb\sqrt{2g}\left\{\tfrac{2}{3}\left[(h_1+k)^{\frac{3}{2}} - k^{\frac{3}{2}}\right] + (h-h_1)(h_1+k)^{\frac{1}{2}}\right\}$$

$$(14) \qquad Q'' = mb''\sqrt{2g}\left\{\tfrac{2}{3}\left[(h_1+k)^{\frac{3}{2}} - k^{\frac{3}{2}}\right] + (h''-h_1)(h_1+k)^{\frac{1}{2}}\right\}$$

but

$$(15) \qquad Q' + Q'' = Q$$

and

$$h'' = h - g$$

g being the guard of the lock.

Adding equations 13 and 14 together and reducing, we have:
(16)

$$\left[(h_1+k)^{\frac{3}{2}} - k^{\frac{3}{2}}\right](b+b'') + \tfrac{3}{2}\left[(b+b'')(h-h_1) - b''g\right](h_1+k)^{\frac{1}{2}} = \frac{3Q}{2m\sqrt{2g}}$$

This is the general equation; omitting the height due to velocity of approach, it becomes

$$(17) \qquad (b+b'')\,h_1^{\frac{3}{2}} + \left[(b+b'')(h-h_1) - b''g\right]h_1^{\frac{1}{2}} = \frac{3Q}{2m\sqrt{2g}};$$

in which all the quantities are known except h_1.

In applying this equation to the case of Dam 1, when the lower gauge reads 134.00, we have the following constants:

$$b = 325 \qquad b'' = 70 \qquad h - h_1 = 20$$

$$g = 13 \qquad Q = 50351, \qquad m = 0.8 \qquad \sqrt{2g} = 8.02.$$

Substituting these in the equation, we have

$$h_1^{\frac{3}{2}} + 26.5443\, h_1^{\frac{1}{2}} = 29.8015\,;$$

whence

$$h_1 = 1.157\,;$$

Finding the velocity of approach we get

$$k = 0.204\,;$$

whence the true value of the fall over the dam is 0.953.

The upper pool therefore stands at the level of 134.95 when the lower pool stands at 134.00.

There is therefore at this stage a fall of nearly 1 foot at Dam No. 1, and it is next necessary to see how much backwater is produced on Dam No. 2.

The formula which we will use for backwater is that of Poirée, which is given by Debauve in his *Manuel de l'Ingenieur*, Vol. 19, page 159, and can also be found in De Lagrené's *Navigation Interieure.*

$$D = H + h - ix + \frac{(ix)^2}{4\,H}, \tag{18}$$

in which

D is the depth at a point above a dam whose distance is x.
H is the increased height caused by the dam at its site.
h is the natural height of water before the dam was built.
i is the sine of the slope.

It is evident from the above that $H + h =$ the distance from the bed of the river to the surface of the pool measured at the site of the dam.

In this formula H, i and x are known, but h must be determined by calculation.

We will use the Chezy formula with 100 as coefficient.

$$V = 100\,\sqrt{ri}, \tag{19}$$

in which

$r =$ mean hydraulic radius; $\qquad i =$ slope of the river;

but we have

$$r = \frac{b\,h}{b + 2\,h};$$

whence

$$V = 100\sqrt{\frac{b\,h\,i}{b + 2\,h}};$$

we also have

$$V=\frac{Q}{b\,h};$$

whence

$$(20)\qquad 100\sqrt{\frac{b\,h\,i}{b+2\,h}}=\frac{Q}{b\,h},$$

which may be reduced to

$$(21)\qquad h^{3}-\frac{2\,Q^{2}}{10000\ b^{3}i}\,h-\frac{Q^{2}}{10000\ b^{2}i}=O.$$

In the case in hand we have

$$Q=50351 \qquad b=395 \qquad i=\tfrac{1}{281}.$$

Substituting these in equation (21) we obtain

$$h^{3}-2.311858\ h-456.592=O;$$

whence

$$h=7.8.$$

Returning to equation (18) we have

$$H+h=136.51-100.00=36.51;$$

whence

$$H=28.71,$$

and the equation becomes

$$D=36.51-\frac{2525}{281}+\frac{\left(\frac{2525}{281}\right)^{2}}{114.84};$$

whence

$$D=28.22.$$

As the reference of the base of Dam No. 2 is 109.00, the present calculation shows that the backwater stands at the reference of 137.22, or 2.22 feet higher than was assumed in the calculations for Dam No. 2.

Revising these calculations on this basis, we obtain, for a lift of 8 feet, a fall over the dam (after correcting for velocity of approach) of 1.10 feet. This is somewhat less than the fall over Dam No. 1 when the lock-walls are at the point of submergence, and therefore the proposed lift of 8 feet will be accepted for Dam No. 2. The level of the upper pool at the stage of 134.00 in the river becomes 138.32, and as the bottom is at reference 109.00, the height of the lock-walls will be placed at 29 feet.

Taking up Dam No. 3, and temporarily assuming that there is no backwater from Dam No. 2, we find that at the stage of 149.00 on the gauge Dam No. 3 will have a fall of 1.23 feet, and as the backwater stands at 150.8, the upper pool level will be 152.03. The site being at reference 118.5, the lock-walls would have to be 33½ feet high. As this height is an excessive one, the walls will be limited to 30 feet. With this height of walls the lock will be submerged at the stage of about 145.3 on the gauge at the landing, and the fall over the dam will be 1.42 feet.

If we calculate the fall over Dam No. 2 at this stage, we will find that the dam is drowned out, and that therefore the backwater on Dam No. 3 was correctly obtained from the natural slope of the river, the fall between No. 3 and the gauge at the landing being 1.8 feet.

As the table of discharges does not go beyond the stage of 149 feet on the gauge, the fall at No. 4 has been calculated for this stage and found to be 2.73 feet. As this is more than the fall over No. 3 at the same stage, it is evident that No. 4 will be drowned out after No. 3, as is desired.

In the absence of calculated discharges at higher gauge readings than 149, it is not practicable to go further into the investigation of the falls at submergence and heights of lock-walls at Dams 4 and 5. As a long time will probably elapse before the construction of these dams is begun, the Board would recommend that the lifts of dams and heights of lock-walls which Mr. Harding has recommended at these sites be provisionally adopted, subject to modification in case further information should prove it to be advisable.

The following table shows the various measurements of the dams as recommended for adoption:

Dam.	Length of spill.	Height of dam.	Lift of dam.	Height of lock-walls.	Guard.	Fall at epoch of submergence.
1	325	14	14	27	18	1.19
2	410	18	8	29	16	1.12
3	620	18.5	10	30	16.5	1.43
4	710	17	9	29	12	....
5	892	13	11	24	11	....

As all of the above have been calculated for the maximum discharge, which usually lasts but a short time, the conditions will become more favorable as the river comes to a stand or begins to fall. It will be observed that no change has been made in the lifts of the dams, as given in the project submitted to the Board, and but slight changes in the heights of the lock-walls.

The estimates accompanying Major Damrell's report are manifestly too low, and, in view of the changes advised by the Board, it is recommended that new estimates be made. The Board recognize the importance of having the proposed work commenced during the coming season, in order that the benefit to be received from it may be realized with as little delay as possible. For this reason it is suggested that work be begun without waiting for a revision of the estimates.

As much of the preceding discussion is of the nature of original investigation in the application of the formulæ used to ascertain the proper heights of the dams in improving a river by slackwater navigation, the Board, in order to give additional weight to the results obtained and to render the research more exhaustive, have applied the formulæ to the Kentucky River, substituting in them the data before mentioned.

The Kentucky has been improved with five locks and dams, giving slackwater navigation for a distance of 100 miles. The lengths of the dams vary from 428 feet to 550 feet, and their lifts from 16.77 feet to 12.84 feet. The five dams have a total lift of 72.44 feet. The pools are from 11 miles to 27 miles in length. The tops of lock-walls are from 29.10 feet to 32.41 feet above the lower miter-sills, and their guards above the dams are from 9 feet to 10.25 feet.

This river, like the Black Warrior, is subjected to sudden freshets, which rise from 20 feet to 30 feet above the tops of the lock-walls. The principal differences between the portion of the Black Warrior under discussion, and the improved portion of the Kentucky are the exceedingly steep bottom slopes in the former, and its freedom from tributaries having any influence on its regimen. The Kentucky in its shortest pool has a bottom slope of but 1.226 feet per mile, in comparison with 18 feet to the mile in the shortest pool of the Black Warrior River, and the flow of water through all the pools is materially affected by numerous tributaries, which bring in large quantities of water after heavy local rains. It might also be noted that the flow from the Kentucky is considerably retarded by backwater from the Ohio, which, in the highest floods, may cause an increased height of water in four of the pools. In the cases selected for comparison with the Black Warrior, which are the two freshets of February and March, and of March and April, 1886, the effect of the backwater from the Ohio is believed to have been a minimum, except during the latter part of the second rise.

The data which are compiled in the accompanying tables are the daily simultaneous readings of gauges placed at the head and foot at each of the locks. From these the fall in the pools and that over the dams have been obtained for all the days during which the freshet lasted. To find the quantity, Q, discharged over the several dams at the various stages of water, we use formula (1) which is:

$$(1)\quad Q=mb\sqrt{2g}\left\{\tfrac{2}{3}\left[(h_1+k)^{\frac{3}{2}}-k^{\frac{3}{2}}\right]+(h-h_1)(h_1+k)^{\frac{1}{2}}\right\}$$

Neglecting the velocity of approach the formula becomes:

$$Q=mb\sqrt{2\,g}\left[\tfrac{2}{3}\,h_1^{\frac{3}{2}}+(h-h_1)\,h_1^{\frac{1}{2}}\right]$$

In this all the quantities are known except Q, and, by making the proper substitutions, its value can be obtained at each of the dams for all of the days in the tables.

To find the quantity discharged over Dam No. 2 on March 29, at the time of the observation, we first find the approximate value of Q from the formula, neglecting the velocity of approach. For this dam, $b=432$, and for the day selected, $h=5.9$, and $h_1=5.5$; m and g have the values of 0.8 and 32.16 as before.

Making these substitutions the formula becomes:

$$Q=0.8\times 432\times 8.02\left[\tfrac{2}{3}(5.5)^{\frac{3}{2}}+(5.9-5.5)\,(5.5)^{\frac{1}{2}}\right]$$

Whence:

$$Q=26434$$

This gives the quantity of water passing over the dam, or flowing through the river, if we ignore the velocity of approach.

Let us now ascertain to what extent the velocity of approach will affect the quantity discharged.

Find the value of k as before from equation (6), which is:

$$(6)\quad K=\frac{Q^2}{64.4\times b^2\times(h+d)^2}$$

For Dam No. 2 in this equation—

$Q=26434.$
$b=432+54=486.$
$h=5.9.$
$d=14{,}4+5.7$, the height of the dam above the bottom of the river,

Making these substitutions:

$$K=\frac{(26434)^2}{64.4\times(486)^2\times(26)^2}=0.0679$$

Resuming formula (1) and substituting for *k* this value, we have:

$$Q=0.8\times432\times8.02\left\{\tfrac{2}{3}\left[(5.5+0.0679)^{\frac{3}{2}}-(0.0679)^{\frac{3}{2}}\right]+(5.9-5.5)\,(5.5+0.0679)^{\frac{1}{2}}\right\}$$

Whence:

$$Q=26886.$$

The quantity obtained for the discharge over the dam on this day has therefore been increased 1¾ per cent. by considering the velocity of approach.

As it was impossible in the time allowed for the preparation of this report to find the quantities discharged over all the dams in all the stages of water presented in the tables, and to continue the discussion as desired, only such of the data have been used as were believed to be sufficient to show to what degree the calculations made for the Black Warrior River dams are reliable.

Upon the Kentucky River the pool of Dam No. 2 contains the steepest bottom slope. This dam has, therefore, been selected for discussion, as its effect in producing backwater and assisting in drowning Dam No. 3 during rises more nearly resembles the backing up of the water likely to be caused by Dam No. 1 of the Black Warrior upon Dam No. 2, than that of the other dams whose pools have less bottom slope.

The quantities of water passing over this dam have been calculated in the manner indicated for each day of the freshet, extending from March 20 to April 26. When the water was over the top of the lock-walls, the quantities were obtained by finding the values of Q' and Q'', and taking the sum for Q, as was done in calculating the discharge of the Black Warrior under this condition. These have been tabulated as follows:

Kentucky River.

Date.	Discharges, Dam No. 2.	Depth corresponding to discharge before construction of dam.	Calculated depth of water below Dam No. 3.	Observed depth of water below Dam No. 3.	Observed depth of backwater on Dam No. 3.	Remarks.
1886.						
Mar. 20	3,895	2.76	10.4	8.3	0.0	Without velocity of approach.
21	5,621	3.86	12.2	8.6	0.0	Do.
22	5,621	3.86	12.2	8.9	0.0	Do.
23	26,481	10.85	15.9	15.1	0.0	Do.
24	30,452	11.78	16.9	18.1	0.0	Do.
25	28,022	11.10	15.9	15.2	0.0	Do.
26	17,054	7.98	13.7	12.2	0.0	Do.
27	11,584	6.20	12.6	10.4	0.0	Do.
28	13,183	6.74	12.9	11.4	0.0	Do.
29	26,886	10.80	15.5	15.7	0.0	With velocity of approach.
29	26,434	10.63	15.4	15.7	0.0	Without velocity of approach.
30	39,625	14.48	20.8	23.0	3.7	With velocity of approach.
30	38,151	14.10	20.7	23.0	3.7	Without velocity of approach.
31	61,486	19.88	25.3	28.6	9.2	Do.
Apr. 1	60,983	18.44	27.7	31.5	12.2	Do.
2	20,788	9.13	28.0	32.3	13.0	Do.
3	38,801	13.75	30.8	33.8	14.5	Do.
4	94,370	22.23	34.3	37.5	18.2	Do.
5	96,830	24.84	38.7	41.0	22.3	Do.
6	101,940	25.09	40.1	42.4	23.1	Do.

Kentucky River—Continued.

Date.	Discharges, Dam No. 2.	Depth corresponding to discharge before construction.	Calculated depth of water below Dam No. 3.	Observed depth of water below Dam No. 3.	Observed depth of backwater on Dam No. 2.	Remarks.
1886.						
Apr. 7	100,243	25.81	39.7	42.0	22.8	Without velocity of approach.
8	72,704	20.71	39.9	42.5	23.3	Do.
9	67,921	19.02	39.3	41.7	22.4	Do.
10	66,466	19.42	37.4	39.3	20.0	Do.
11	54,389	18.90	30.9	33.9	14.6	Do.
12	42,600	14.58	27.7	28.0	8.7	Do.
13	42,600	14.58	27.7	27.3	8.0	Do.
14	43,922	14.75	23.7	22.7	3.4	Do.
15	4,908	3.53	19.2	18.6	0.0	With velocity of approach.
16	3,160	2.63	15.4	14.7	0.0	Do.
17	13,385	6.41	13.3	11.9	0.0	Without velocity of approach.
18	11,584	6.20	12.6	10.7	0.0	Do.
19	9,124	5.33	12.0	10.3	0.0	Do.
20	7,744	4.87	11.7	9.8	0.0	Do.
21	6,868	4.41	11.4	9.4	0.0	Do.
22	5,621	3.86	11.1	9.0	0.0	Do.
23	4,830	3.50	10.9	8.8	0.0	Do.
24	4,091	3.18	10.7	8.6	0.0	Do.
25	4,091	3.18	10.7	8.5	0.0	Do.
26	4,091	3.18	10.7	8.3	0.0	Do.

The effect of velocity of approach has been ignored in obtaining the discharges, except upon March 29 and 30, when it was introduced for comparison, and upon April 15 and 16, when there was no fall over the dam, and it was completely drowned. It might be observed in this connection that the velocity of approach has a proportionately greater effect upon the quantities discharged, other things being equal, as the fall over the dam diminishes and as the height of the water upon the crest of the dam increases.

The discharge over all the dams in the Kentucky upon March 29 and 30 have been calculated for comparison, and also to show the progress of the freshet wave. They are contained in the following table:

Kentucky River.

Date.	Dam.	Discharges.	Depth corresponding to discharge before construction of dam.	Calculated depth of water below dams.	Observed depth of water below dams.	Height of dams above bottom.	Observed depth of backwater on dams.
March 29.....	1....	32,012	15.15	....	27.70	22.57	5.13
Do	2....	26,885	10.80	17.40	20.50	20.10	0.40
Do	3 ..	31,181	14.56	15.44	15.70	19.35	0.0
Do	4....	36,045	16.22	16.65	18.30	20.14	0.0
Do	5....	33,241	17.58	18.00	20.62	20.68	0.0
March 30.....	1....	40,589	17.53	....	32.50	22.57	9.93
Do	2....	39,625	14.48	21.36	30.30	20.10	10.20
Do	3 ...	53,765	20.78	20.79	23.00	19.35	3.65
Do	4....	49,930	19.53	20.91	28.00	20.14	7.86
Do	5....	37,511	19.01	21.14	28.42	20.68	7.74

In the above table velocity of approach was considered in obtaining the quantities.

Having obtained the quantities discharged over Dam No. 2, let us now ascertain the depths of the water immediately below Dam No. 3, in the same manner as the heights of the backwater were obtained for the dams upon the Black Warrior. The following is equation (18), which was used for this purpose:

$$(18) \qquad D = H + h - ix + \frac{(ix)^2}{4H}$$

In this:

D is the depth of water just below Dam No. 3;
$H+h$ is the observed height of water above the bottom at Dam No. 2;
h is the natural height of water before dam was built;
i is the sine of the slope;
x is the length of pool 2;
ix is the total fall of the bottom in pool $2=13.6$ feet.

All the quantities in this equation are known, except h, which must be calculated.

Using equation (21), which is:

$$(21) \qquad h^3-\frac{2\,Q^2}{10000\,b^3 i}-\frac{Q^2}{10000\,b^2 i}=0$$

and making $Q=26434$, the quantity discharged upon the 29th, ignoring the velocity of approach.

$$b=486 \qquad i=\frac{1.226}{5280}$$

We have:

$$h^3-5.2475\,h-1275.15=0$$

Whence:

$$h=10.63$$

But $H+h$ for the 29th March$=26$.

Therefore:

$$H=15.37.$$

Substituting the values of $H\,h$ and ix in equation (18) we have:

$$D=26.0-13.6+\frac{(13.6)^2}{61.48}$$

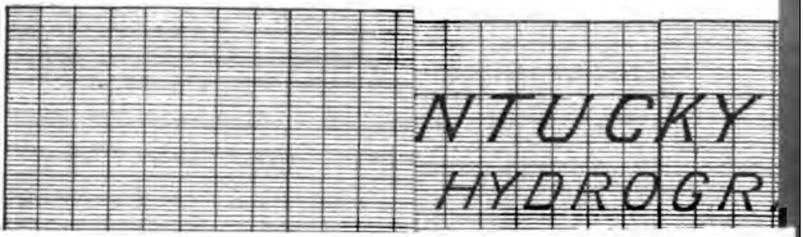
Whence

$$D=15.4$$

The values of h and D have been calculated in this manner for all the days upon which the quantities discharged by the river have been obtained, and have been inserted in the table. The observed depths of water immediately below Dam No. 3 have also been placed in the same tables.

Comparing the last two columns of the preceding tables we see that the calculated depths are greater than the observed depths while the river is at its lower stages. As the river rises and the spill over Dam No. 3 increases, the observed depths increase more rapidly than those calculated, until, when the highest stage is reached, the observed depths are from 2 feet to 3 feet greater than those calculated. When the river falls these values again approach each other, become equal, and finally, at the lower stages the calculated heights are again the larger. It should be observed that the equality of values in these two quantities takes place at a much lower stage of water on a rising river than on a falling one. At Dam No. 3 when D is greater than the height of the crest of the dam above the bottom of the river, which is equal to $12.84+6.51$, or 19.35 feet, Dam No. 2 produces backwater upon Dam No. 3. In the example before us it will be noted that on the rising river the calculated and observed depths below Dam No. 3 become equal about the time backwater began to appear upon Dam 3. On a falling river these quantities become equal while backwater still remained on Dam. 3.

Thus far all the calculations made have been based upon data taken from the rise of March 20 to April 26, 1886, and during this rise there were about ten days when steamers could pass over Dam No. 3.


NTUCKY
HYDROGR.

ow turn to the rise of February 9 to March 7, during which
though the water rose more than 2 feet above the top of the
Lock No. 3, yet the fall over the dam was too great to permit
pass over it. We will first consider the conditions existing
bruary 14, when the depth on the lock-walls was the greatest
during the rise, and the fall over Dam No. 3 was the least.
ting the proper values for the quantities in equation (1) for
. 2 for this day, and reducing, we have:

$$Q = 38247$$

uantity of water passing over No. 2.

e velocity of approach is considered this becomes:

$$Q = 40369$$

ing the value of h by means of equation (21), and, finally, the
D by equation (18), we have:

$$D = 24.6$$

same day the observed value is:

$$D = 28.5$$

lue of D has also been obtained from equations (21) and (18)
2th of April, when the water was only 7.4 feet upon the crest
No. 2, and the walls of 2 and 3 were not submerged. By mak-
roper substitution for this day, we obtain:

$$D = 16.95$$

observed value is:

$$D = 18.0$$

iscussion shows that in the two freshets under consideration
rved depths of the backwater upon Dam No. 3, resulting from
. 2, were greater than those obtained from applying the for-
d for calculating the amount of backwater upon the Black
dams. The Board therefore feel warranted in stating that on
river the proposed dams on the Black Warrior will generally
ed out at an earlier period than is indicated by calculation.
r, the falls over these dams have been determined for a rising
for maximum discharges, and they will decrease as the river
a stand and begins to fall. Under any circumstances, there-
re are good reasons for believing that in this part of the Black
River it will seldom happen that the locks are submerged
dams can not be run by boats.
ded hereto are two tables containing the data obtained by ob-
s from the Kentucky River during the two freshets referred
se have been platted, and two sheets of the resulting hydro-
ccompany this report.
espectfully submitted,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
WM. E. MERRILL,
Lieut. Col. of Engineers.
W. R. KING,
Major of Engineers.
A. N. DAMRELL,
Major of Engineers.
JAS. C. POST,
Major of Engineers.

HIEF OF ENGINEERS, U. S. A.

Heights of water of Kentucky River at the several dams during the rises extending

Date.	Dam No. 5.—550′ long; lift, 14′.16; guard of lock, 10′.14; length of pool 5, 14.6 miles; slope of bottom, 0′.95 per mile; normal depth of water on lower miter-sill, 6′.4.			Dam No. 4.—528′ long; lift, 14′.27; guard of lock, 10′; length of pool 4, 17.2 miles; slope of bottom, 0′.79 per mile; normal depth of water on lower miter-sill, 5′.87.						Dam No. 3.—464′ long; lift, 12′.84; guard of lock, 9′.2; length of pool 3, 23.1 miles; slope of bottom, 0′.584 per mile; normal depth of water of lower miter-sill, 6′.51.					
	Height of water on crest of dam.	Height of water above normal level below dam.	Fall over dam.	Height of water on crest of dam.	Height of water above normal level below dam.	Fall over dam.	Fall in pool 4.	Fall in pool and over dam.	Average fall per mile in pool 4.	Height of water on crest of dam.	Height of water above normal level below dam.	Fall over dam.	Fall in pool 3.	Fall in pool and over dam.	Average fall per mile in pool 3.
1886.															
Feb. 9.	1.43	2.80	12.79	1.96	3.63	12.60	0.84	13.44	0.049	1.90	2.39	12.35	1.73	14.08	0.075
Feb. 10.......	1.63	3.30	12.49	2.46	4.43	12.30	0.84	13.14	0.049	2.40	2.99	12.25	2.03	14.28	0.087
Feb. 11.......	3.03	6.50	10.69	3.46	6.13	11.60	3.04	14.64	0.176	3.30	4.29	11.85	2.83	14.68	0.122
Feb. 12.......	6.23	15.60	4.79	6.96	14.13	7.10	8.64	15.74	0.502	6.20	11.49	7.55	7.93	15.48	0.343
Feb. 13.......	11.83	24.80	1.19	12.46	26.73	0.00	12.34	12.34	0.717	11.60	19.99	4.45	15.13	19.58	0.655
Feb. 14.......	11.53	24.40	1.29	12.36	26.53	0.00	12.04	12.14	0.700	11.90	21.99	2.75	14.63	17.38	0.633
Feb. 15.......	11.43	24.20	1.39	11.66	25.13	0.80	12.54	13.34	0.728	11.60	21.49	2.95	13.53	16.48	0.585
Feb. 16.......	7.03	20.30	1.79	10.26	24.53	0.00	10.04	10.04	0.583	9.50	19.49	2.85	15.03	17.88	0.650
Feb. 17.......	5.23	14.10	5.29	9.46	20.13	3.60	4.64	8.24	0.270	6.40	13.99	5.25	13.73	18.98	0.594
Feb. 18.......	4.03	10.10	8.09	5.76	12.43	7.60	4.34	11.94	0.251	5.60	8.49	9.95	6.83	16.78	0.296
Feb. 19.......	3.43	8.60	8.99	4.46	10.33	8.40	4.14	12.54	0.240	5.00	7.59	10.25	5.33	15.58	0.231
Feb. 20.......	2.83	7.10	9.89	3.56	9.63	8.20	3.54	11.74	0.205	4.50	6.59	10.75	5.13	15.88	0.222
Feb. 21.......	2.33	5.70	10.79	3.26	6.73	10.80	2.44	13.24	0.141	3.70	5.19	11.35	3.03	14.38	0.131
Feb. 22.......	2.03	4.60	11.59	2.86	5.63	11.50	1.74	13.24	0.101	3.30	4.39	11.75	2.33	14.08	0.101
Feb. 23.......	1.63	3.90	11.89	2.46	4.63	12.10	1.44	13.54	0.083	2.80	3.69	11.95	1.83	13.78	0.079
Feb. 24......	1.53	3.90	11.79	1.96	4.13	12.10	1.94	14.04	0.112	2.60	3.29	12.15	1.53	13.68	0.066
Feb. 25......	1.43	3.60	11.99	2.56	6.03	10.80	1.04	11.84	0.061	2.70	4.19	11.35	3.33	14.68	0.144
Feb. 26.......	1.53	3.80	11.89	2.66	4.63	12.00	1.44	13.44	0.083	2.80	3.68	11.95	1.83	13.78	0.079
Feb. 27.......	2.23	5.10	11.29	2.96	6.13	11.10	2.14	13.24	0.124	3.40	3.50	12.74	2.73	15.47	0.118
Feb. 28......	2.33	5.40	11.09	2.96	6.13	11.10	2.44	13.54	0.141	3.30	4.30	11.75	2.83	14.58	0.122
Mar. 1.......	2.33	5.40	11.09	2.86	5.93	11.20	2.54	13.74	0.148	3.40	4.49	11.75	2.53	14.28	0.109
Mar. 2........	1.93	4.70	11.39	2.86	5.93	11.20	1.84	13.04	0.107	3.10	3.99	11.95	2.83	14.78	0.122
Mar. 3.......	1.63	4.00	11.79	2.46	4.93	11.80	1.54	13.34	0.089	2.80	3.59	12.05	2.13	14.18	0.092
Mar. 4......	1.43	3.40	12.19	1.96	4.13	12.10	1.44	13.54	0.083	2.50	3.09	12.25	1.63	13.88	0.114
Mar. 5.......	1.23	3.40	11.99	1.96	3.93	12.30	1.44	13.74	0.083	2.10	2.59	12.35	1.83	14.18	0.079
Mar. 6.......	1.13	2.50	12.79	1.36	3.13	12.50	1.04	13.64	0.060	1.90	2.29	12.45	1.23	13.68	0.053
Mar. 7.......	0.93	2.20	12.89	1.16	3.03	12.40	1.04	13.44	0.060	1.70	1.99	12.55	1.33	13.88	0.057
Mar. 20.......	0.83	1.80	13.19	1.46	2.83	13.40	0.34	13.74	0.019	1.50	1.79	12.55	0.83	13.38	0.036
Mar. 21.......	0.93	2.10	12.99	1.66	2.63	13.30	0.44	13.74	0.026	1.70	2.09	12.45	0.93	13.38	0.040
Mar. 22.......	1.93	3.00	13.09	1.96	3.53	12.70	1.04	13.74	0.061	2.00	2.39	12.45	1.53	13.98	0.066
Mar. 23.......	5.63	14.60	5.19	5.76	14.13	5.90	8.84	14.74	0.514	5.90	8.59	10.15	8.23	18.38	0.356
Mar. 24.......	5.83	15.80	4.19	6.96	16.03	4.60	8.84	13.44	0.514	7.20	11.59	8.45	9.43	17.88	0.408
Mar. 25.......	4.13	10.00	7.39	5.26	12.03	6.90	5.64	12.54	0.322	5.80	8.09	9.95	6.83	16.78	0.296
Mar. 26.......	2.83	6.70	10.29	3.56	8.33	9.50	3.14	12.64	0.182	4.00	5.69	11.15	4.33	15.48	0.187
Mar. 27.......	2.13	5.00	11.29	2.96	6.13	11.10	2.04	13.14	0.122	3.10	3.89	12.05	3.03	15.08	0.131
Mar. 28.......	3.03	6.80	10.39	5.46	8.13	11.60	1.34	12.94	0.077	3.70	4.80	11.65	4.43	16.08	0.192
Mar. 29.......	5.63	14.10	5.69	6.36	12.48	8.20	7.74	15.94	0.450	6.20	9.19	9.85	6.23	16.08	0.270
Mar. 30.......	9.03	21.90	1.29	10.06	22.13	2.20	11.84	14.04	0.688	9.20	16.49	5.55	12.93	18.48	0.560
Mar. 31.......	11.83	24.80	1.19	12.96	26.13	1.10	11.84	12.94	0.688	10.60	22.09	1.40	15.53	16.93	0.672
Apr. 1.......	13.64	27.80	0.00	15.26	28.63	0.90	12.54	13.44	0.728	12.90	24.99	0.75	15.73	16.48	0.681
Apr. 2.......	14.94	29.10	0.00	15.56	29.13	0.70	13.54	14.24	0.787	13.70	25.79	0.75	15.43	16.18	0.668
Apr. 3.......	16.24	30.40	0.00	17.56	31.63	0.20	12.81	13.01	0.746	15.00	27.29	0.55	16.63	17.18	0.715
Apr. 4.......	21.14	35.30	0.00	22.56	36.73	0.10	12.74	12.84	0.740	18.60	30.99	0.45	18.13	18.58	0.784
Apr. 5.......	24.13	37.60	0.69	26.66	40.94	0.00	10.94	10.94	0.636	22.70	35.09	0.45	18.23	18.68	0.789
Apr. 6.......	23.13	36.10	1.19	25.16	36.13	3.30	10.94	14.24	0.636	23.30	35.89	0.25	12.83	15.08	0.555
Apr. 7.......	22.93	35.70	1.39	23.96	34.13	4.10	11.74	15.84	0.682	22.90	35.59	0.15	11.23	11.38	0.486
Apr. 8.......	22.93	35.70	1.39	24.66	35.35	3.60	11.04	14.64	0.630	23.30	35.99	0.15	12.03	12.18	0.521
Apr. 9.......	20.63	33.10	1.69	22.46	31.33	5.40	10.64	16.04	0.618	22.50	35.19	0.15	8.83	8.98	0.382
Apr. 10.......	17.13	28.60	2.69	17.96	27.43	4.80	10.64	15.44	0.618	20.20	32.79	0.25	7.23	7.48	0.313
Apr. 11.......	10.03	19.90	4.29	11.96	25.93	0.30	7.94	8.24	0.462	15.00	27.39	0.45	10.93	11.38	0.474
Apr. 12.......	5.53	15.50	4.19	8.46	15.33	7.40	7.04	14.44	0.409	9.20	21.49	0.55	6.13	6.68	0.265
Apr. 13.......	4.33	11.80	6.69	5.46	11.13	8.60	6.34	14.94	0.369	9.20	20.79	1.25	1.93	3.18	0.083
Apr. 14.......	3.63	9.60	8.19	4.46	10.63	8.10	5.14	13.24	0.300	5.90	16.19	2.55	4.73	7.28	0.205
Apr. 15.......	3.13	7.80	9.49	4.46	9.63	9.10	3.34	12.44	0.194	4.90	12.09	5.65	4.73	10.38	0.205
Apr. 16.......	2.63	6.60	10.19	3.36	8.13	9.50	3.24	12.74	0.188	4.10	8.19	8.75	4.03	12.78	0.174
Apr. 17.......	2.33	5.70	10.79	2.96	7.33	9.90	2.74	12.64	0.160	3.60	5.39	11.05	3.73	14.78	0.161
Apr, 18.......	1.93	4.80	11.29	2.66	6.63	10.80	2.14	12.44	0.124	3.10	4.19	11.75	3.53	15.28	0.153
Apr. 19.......	1.63	4.00	11.79	2.46	5.33	11.40	1.54	12.94	0.080	2.90	3.79	11.95	2.43	14.38	0.105
Apr. 20.......	1.43	3.40	12.19	2.26	4.93	11.60	1.14	12.74	0.066	2.60	3.29	12.15	2.33	14.48	0.101
Apr. 21.......	1.43	3.40	12.10	1.96	4.13	12.10	1.44	13.54	0.083	2.20	2.89	12.15	1.93	14.08	0.083
Apr. 22..... ..	1.03	2.60	12.59	1.96	3.43	12.80	0.64	13.44	0.004	1.90	2.49	12.25	1.53	13.78	0.066
Apr. 23......	1.03	2.30	12.69	1.96	3.13	13.10	0.34	13.44	0.002	1.80	2.29	12.35	1.33	13.68	0.057
Apr. 24.......	0.93	2.00	13.09	1.86	2.83	13.30	0.14	13.44	0.008	1.70	2.09	12.45	1.13	13.58	0.049
Apr. 25.......	0.83	1.90	13.09	1.46	2.03	13.10	0.44	13.54	0.026	1.60	1.99	12.45	1.03	13.48	0.044
Apr. 26.......	0.73	1.60	13.29	1.36	2.33	13.30	0.24	13.54	0.014	1.50	1.79	12.55	0.83	13.38	0.036

from February 9 *to March* 7, 1886, *and from March* 20 *to April* 26, 1886.

Dam No. 2.—432′ long; lift 14′.40; guard of lock, 9′; length of pool 2, 11.1 miles; slope of bottom, 1′.226 per mile; normal depth of water on lower miter-sill, 5′.7.						**Dam No 1.**—428′ long; lift, 16′.77; guard of lock, 10′.25; length of pool 1, 26.9 miles; slope of bottom, 0′.625 per mile; normal depth of water on lower miter-sill, 5′.8.					
Height of water on crest of dam.	Height of water above normal level below dam.	Fall over dam.	Fall in pool 2.	Fall in pool and over dam.	Average fall per mile in pool 2.	Height of water on crest of dam.	Height of water above normal level below dam.	Fall over dam.	Fall in pool 1.	Fall in pool and over dam.	Average fall per mile in pool 1.
2.00	3.30	13.10	0.39	13.49	0.033	1.96	9.20	9.43	1.34	10.77	0.050
2.50	4.80	12.10	0.49	12.59	0.042	2.56	8.00	11.33	2.24	13.57	0.089
3.40	6.80	11.00	0.89	11.89	0.077	3.26	9.20	10.83	3.54	14.37	0.131
7.40	18.30	3.50	4.09	7.59	0.368	7.16	12.90	11.03	11.14	22.17	0.414
15.40	29.30	0.50	4.59	5.09	0.414	11.06	20.70	7.13	18.24	23.37	0.678
16.10	29.80	0.70	5.89	6.59	0.530	11.76	25.20	3.33	18.04	21.37	0.671
15.40	29.30	0.50	6.09	6.59	0.548	12.56	27.70	1.63	16.74	18.86	0.623
14.40	28.30	0.50	5.09	5.59	0.458	13.16	28.80	1.13	15.14	16.27	0.563
9.90	24.30	0.00	4.09	4.09	0.368	13.46	29.70	0.53	10.84	11.37	0.441
6.90	18.80	2.50	1.59	4.09	0.143	13.46	30.00	0.23	5.34	5.57	0.199
5.50	17.50	2.40	2.09	4.49	0.188	13.46	30.10	0.13	4.04	4.17	0.150
4.90	16.20	3.10	1.69	4.79	0.151	12.71	29.30	0.18	3.49	3.67	0.130
3.40	13.30	4.50	1.79	6.29	0.160	10.36	26.90	0.23	2.94	3.17	0.110
3.40	10.30	7.50	0.99	8.49	0.090	7.46	23.00	0.33	2.84	3.17	0.106
2.90	7.30	10.00	0.79	10.79	0.071	4.76	20.90	0.63	2.51	3.17	0.099
2.60	6.50	11.50	0.69	12.19	0.060	2.96	18.20	1.53	2.54	4.07	0.099
3.40	6.30	11.50	0.79	12.29	0.071	3.26	16.60	3.43	3.04	6.47	0.114
2.90	6.80	10.50	0.79	11.29	0.071	3.96	17.30	3.43	2.84	6.27	0.106
3.50	7.50	10.40	0.00	10.40	0.000	3.66	16.20	4.23	3.84	8.07	0.144
3.60	7.60	10.40	0.79	11.09	0.071	3.66	14.80	5.63	3.94	9.57	0.147
3.50	7.50	10.40	0.99	11.39	0.090	3.66	14.20	6.23	3.84	10.07	0.144
3.30	7.00	10.70	0.69	11.39	0.063	3.46	14.40	5.83	3.54	9.37	0.131
2.90	6.00	11.30	0.69	11.99	0.063	3.06	14.70	5.13	2.94	8.07	0.110
2.60	5.30	11.70	0.49	12.19	0.045	2.66	14.60	4.83	2.64	7.47	0.099
2.40	4.50	12.30	0.19	12.49	0.017	2.81	13.90	5.13	2.19	7.37	0.083
2.10	3.80	12.70	0.19	12.89	0.017	2.16	12.80	6.13	1.64	7.77	0.060
1.90	3.30	13.00	0.09	13.09	0.008	1.86	12.40	6.23	1.44	7.67	0.053
1.50	3.10	12.80	0.29	13.09	0.002	1.46	7.80	10.43	1.64	12.07	0.006
2.10	3.50	13.00	0.00	13.00	0.000	1.76	8.20	10.33	1.74	12.07	0.006
2.10	3.50	13.00	0.29	13.29	0.002	2.16	9.10	9.83	1.34	11.17	0.004
5.90	13.30	7.00	2.69	9.69	0.242	5.16	12.10	9.83	8.14	17.07	0.302
7.50	19.10	2.80	4.09	6.89	0.368	7.36	18.10	6.03	11.74	17.77	0.436
6.40	16.80	4.00	2.29	6.29	0.206	7.06	21.50	2.33	9.74	12.07	0.324
4.40	10.90	7.90	1.29	9.19	0.116	6.06	22.10	0.73	4.84	5.57	0.181
3.40	8.50	9.30	0.49	9.79	0.004	5.66	22.20	0.23	2.84	3.07	0.106
3.70	9.10	9.00	1.19	10.19	0.107	5.56	21.70	0.63	3.54	4.17	0.131
5.90	14.80	5.50	3.29	8.79	0.296	6.66	21.90	1.53	8.14	9.67	0.302
11.60	24.60	1.40	4.89	6.29	0.440	11.36	26.70	1.43	13.24	14.67	0.498
16.90	29.80	1.50	5.19	6.69	0.463	15.26	31.30	0.73	14.84	15.27	0.542
19.90	33.30	1.00	5.09	6.09	0.458	18.36	34.70	0.43	14.94	15.37	0.555
21.00	35.30	0.10	4.79	4.89	0.431	20.96	37.00	0.73	14.34	15.07	0.533
22.70	36.80	0.30	4.59	4.89	0.414	23.76	40.00	0.53	13.04	13.57	0.503
25.90	39.30	1.00	5.09	6.09	0.458	25.46	42.10	0.13	13.84	13.97	0.514
30.40	43.80	1.00	4.69	5.69	0.422	27.26	43.80	0.23	16.54	16.77	0.615
31.90	45.30	1.00	3.99	4.99	0.359	28.26	44.80	0.23	17.04	17.37	0.633
31.40	44.80	1.00	4.19	5.19	0.377	28.56	45.10	0.23	16.24	16.47	0.603
31.90	45.80	0.50	4.09	4.59	0.368	29.06	45.60	0.23	16.74	16.97	0.629
31.40	45.30	0.50	3.79	4.29	0.341	29.56	46.10	0.23	15.74	15.97	0.585
29.40	43.30	0.50	3.39	3.89	0.305	29.46	46.00	0.23	13.84	14.07	0.514
24.40	38.30	0.50	2.99	3.49	0.269	28.46	45.10	0.13	9.84	9.97	0.365
19.40	33.30	0.50	2.09	2.59	0.188	27.46	44.10	0.13	5.84	5.97	0.217
19.40	33.30	0.50	1.39	1.89	0.124	27.16	43.80	0.03	6.14	6.27	0.228
14.90	28.30	1.00	1.29	2.29	0.116	25.16	41.90	0.03	3.14	5.17	0.117
10.90	25.30	0.00	1.19	1.19	0.107	22.86	39.60	0.03	2.44	2.47	0.098
6.90	21.30	0.00	1.29	1.29	0.116	19.16	35.90	0.03	2.14	2.17	0.080
4.20	16.80	1.80	1.19	2.99	0.107	15.36	32.10	0.03	1.44	1.47	0.005
3.40	12.90	4.90	0.79	5.69	0.006	11.36	28.10	0.03	1.54	1.57	0.605
2.90	9.40	7.90	0.89	8.79	0.007	7.56	24.10	0.23	1.84	2.07	0.006
2.60	6.60	10.40	0.69	11.09	0.005	4.56	21.00	0.33	2.04	2.37	0.007
2.40	4.50	12.30	0.49	12.79	0.004	2.06	18.30	1.13	1.84	2.97	0.007
2.10	3.90	12.60	0.39	12.99	0.008	2.16	15.10	3.83	1.74	5.57	0.006
1.90	3.50	12.80	0.39	13.19	0.003	1.96	14.20	4.53	1.54	6.07	0.005
1.70	3.00	13.10	0.39	13.49	0.003	1.86	12.90	5.73	1.14	6,87	0.005
1.50	2.80	13.10	0.49	13.59	0.004	1.66	11.30	7.13	1.14	8.27	0.006
1.50	2.50	13.40	0.29	13.69	0.002	1.56	10.40	7.93	0.94	8.87	0.004

APPENDIX TO REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, March 31, 1887.

COLONEL: Since the report on the improvement of the Black Warrior River left Cincinnati, it has occurred to us that it is essential to a full comprehension of the subject, in case a similar investigation were required on another river, that great stress should be laid on the fact that the discharges used in the computations are the *maximum* discharges for the different gauge-readings. As these can not be obtained by direct experiment without observations covering a longer period than is usually available, we have thought it best to show how these maximum discharges were actually obtained on the Black Warrior River.

We therefore forward an extract from a letter of Mr. H. Harding, Assistant Engineer, which we think ought to accompany the Black Warrior report as an appendix.

Your obedient servants,

WM. E. MERRILL,
Lieut-Col. of Engineers.
JAS. C. POST,
Major of Engineers.

Col. W. P. CRAIGHILL,
Corps of Engineers.

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., April 4, 1887.

Respectfully forwarded to the Chief of Engineers.

Agreeing with Lieutenant-Colonel Merrill and Major Post in the opinions expressed herein, I recommend that this letter and its inclosure be attached to and be a part of the report on the improvement of the Black Warrior forwarded with my letter of April 2, 1887.

WM. P. CRAIGHILL,
Colonel of Engineers.

REPORT OF MR. H. HARDING, ASSISTANT ENGINEER.

TUSCALOOSA, *January* 20, 1887.

DEAR SIR: Yours of the 17th instant is received. I have been delayed in preparing the notes you requested, partly, as I wrote you, because some little time was needed to regain a familiarity with a subject so long out of my mind, and partly because the pressure of private affairs would not allow me to devote myself exclusively to volunteer work.

The ganging and gauge-readings that I send you are not as full as I would like. The funds allotted for the survey were not sufficient to allow for stationed observers, and the readings were made as chances offered, suitable opportunities seldom occurring. The gaugings on a rising river were few, because the rises happened to occur mostly at night, or during stormy weather. I have intended all along to extend my observations for verification, whenever work should be commenced. However, the notes obtained are good as far as they go, and sufficient, I believe, to establish quite approximately the results for which they were designed.

The gauges were established as follows:

No. 1. Twelve hundred feet below Tuscaloosa Landing.
No. 2. Head of University Shoals, 2.42 miles.

No. 3. Foot of Ward's Shoals, miles 8.67.
No. 4. Middle of Snider's Shoals, 11.36 miles.
No. 5. Head of Arnold's Shoals, 12.65 miles.

A gauge was also placed at mouth of Daniel's Creek, but the messenger sent to read it reported it lost or destroyed.

The reference in each case was 100, or low water on gauge No. 1.

GAUGE-READINGS.

Condition of river.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Falling	113.0	126.5	....	....	....
Do	116.67	127.33	....	....	....
Rising	116.8	128.80	....	....	....
Do	126.0	130.5	135.5	....	....
Falling	126.4	129.7	133.7	....	....
Do	126.5	129.1	132.0	140.1	145.1
Do	128.0	130.0	132.2	138.3	143.1
On a stand	131.0	132.6	137.6	143.0	....
Rising	135.5	138.2	....	....	....
Falling	138.0	138.8	140.1	144.2	145.5
Do	139.1	139.5	....	....	....
On a stand	142.2	144.0	145.0	149.1	149.9
Do	143.5	145.3	....	....	....
High water	163.0	164.4	168.0	109.5	170.2

High water was determined for three points only: Tuscaloosa Landing, 1,000 feet above North River, and Daniel's Creek. The slope, from point to point, was assumed to be uniform; but, in fact, would probably vary somewhat.

The readings for Nos. 1 and 2 were made simultaneously; the others as nearly so as possible, but the intervals were from one to three hours. On a falling river; the differences from simultaneous readings would not exceed 2 or 3 inches in any case.

For gauging the river I selected a point a little below Tuscaloosa Landing, and at low water took two cross-sections, 100 feet apart, extending them to the tops of the banks. These cross-sections were very nearly coincident, and their average was taken as the cross-section of the entire prism.

State of river.	Gauge-reading.	Maximum velocity.	Coefficient.	Mean velocity.	Area.	Approximate observed discharge.	Estimated maximum discharge.	Remarks.
Falling	108.0	1.5	0.78	1.17	2,925	3,422	5,300	
Rising 3 inches per hour	109.5	1.9	0.8	1.62	3,548	5,700	6,700	C
Falling	113.0	1.54	0.78	1.2	4,912	5,895	10,680	
On a stand	118.0	2.0	0.8	1.6	7,022	11,235	17,730	
Falling	118.0	1.7	0.8	1.36	7,022	9,550	17,730	
Do	124.8	1.8	0.8	1.45	10,145	14,710	29,200	
Do	126.0	2.0	0.8	1.6	10,712	17,139	31,620	
Do	127.8	2.3	0.8	1.84	12,470	22,940	35,500	
On a stand	131.0	3.7	0.81	2.52	13,062	32,917	42,800	
Falling	134.0	1.9	0.8	1.62	14,547	22,566	50,300	
Rising very fast	134.8	4.3	0.82	3.53	14,947	52,762	52,500	B
Falling	138.0	2.8	0.8	2.24	16,582	37,143	62,300	
Rising moderately fast	139.0	4.3	0.82	3.52	17,100	60,360	64,500	D
On a stand	142.2	3.3	0.81	2.7	18,785	50,705	73,700	
Rising 2 feet per hour	145.0	5.0	0.83	4.15	20,125	84,266	83,500	A

Above 145 the banks were overflowed, and no gaugings were taken.

I have given above in each case for comparison the calculated maximum discharge for its gauge-reading. The column was taken from a table prepared as explained below. Case A was assumed as the maximum discharge for its gauge-reading. The current velocity was the greatest observed at any time, and the river had risen from 34 feet of the previous day and came to a stand at 58 feet on the next. The rate of rise was 2 feet per hour at the time of gauging. Case B was taken as the maximum discharge for its stage. It had risen from 16.8 feet of a *falling river* the day before, and reached its height, 42.'2, on the next, before day. Its rate of rise was not recorded, but was noted as very rapid. Taking 5 feet as the maximum velocity for a

45-foot stage, and 4.3 feet as the maximum for a 35-foot stage, and assuming the decrement to be uniform, I prepared a table as follows:

Gauge-reading.	Maximum velocity.	Coefficient.	Mean velocity.
0	1.85	0.8	1.48
5	2.2	0.8	1.76
10	2.55	0.8	2.04
15	2.9	0.81	2.35
20	3.25	0.81	2.63
25	3.6	0.81	2.92
30	3.95	0.82	3.24
35	4.3	0.82	3.52
40	4.65	0.82	3.81
45	5	0.83	4.15

The observed mean velocity for a 1-foot stage was 1.5 feet per second; hence I concluded that the true curve for maximum discharge must approximate quite closely to the one calculated from this table. Cases C and D of the last table would indicate this. The table in full is given in the report.

* * * * * * *

Very truly, etc.,

H. HARDING.

Col. W. E. MERRILL.

Q 3.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

WARRIOR RIVER.

The examination and partial survey of this river was made in 1874, and report thereon may be found in the Report of Chief of Engineers of 1875, Part II, page 16.

In its original condition the river was well adapted for high-water navigation, having a width of 400 feet at Tuscaloosa, gradually reducing to 150 feet near its mouth.

For an average period of five months, during the winter and spring, the navigable depth ranged from 10 to 40 feet, and the chief difficulty experienced was from overhanging trees, which sometimes carried away the chimneys of steamboats and damaged their upper works. Below a 10-foot stage snags began to be troublesome, and when, as summer approached, the river receded to a stage 4 to 5 feet above low water, navigation for all practical purposes was brought to a close.

The obstructions to low-water navigation rendering it impracticable were:

First. Ninety-four bars and reefs, that afforded generally a ruling depth of 18 to 30 inches only, in some cases shoaling to 12 inches.

Second. Numerous snags and sunken logs, occurring mainly in the narrow bar chutes, but frequently met with in the reaches also.

Third. Overhanging trees that, besides being troublesome in high stages, effectually closed narrow chutes, even had they been otherwise navigable.

The improvement of the Warrior was authorized by act of Congress of March 3, 1875, and the project adopted was to deepen the bars, remove the snags, etc., and cut down the overhanging timber, with a view of obtaining for small boats a low-water channel 80 feet in width by 4 feet in depth.

The estimated cost of the improvement was $151,103.

The work was commenced in 1875 and has been prosecuted annually up to November 10, 1885, for an average period of four months in each year, with results as hereinafter given.

The original project called for the improvement of ninety-four bars and reefs, covering an aggregate distance of 14 miles out of a total length of river (Tuscaloosa to Demopolis) of 140 miles.

Forty-nine bars, occupying an aggregate length of 4.64 miles, have been worked upon during those seasons in which the funds available were sufficient to equip and employ a force for this purpose.

The most essential work and a necessary preliminary to bar improvement being the removal of snags and logs, together with the cutting of overhanging timber, the means at hand have been every year largely, and in some seasons wholly, devoted to the prosecution of this work, which has proved of much greater magnitude than expected.

The original estimate of snags to be removed, made from actual count of those in sight, was a little less than 1,100, while up to this time over 7,700 have been taken out. More than 8,400 trees have been also cut from the banks. The work of removing snags and logs has been repeated several times over a great part of the river. This has been made necessary from the obstructions caused by the trees that are every year thrown into the river by land-slides and caving banks. It has also happened in many cases that after clearing a chute from logs, other underlying logs becoming disengaged would, after a while, rise at one end and form fresh obstructions.

The cause of this latter class of obstructions has nearly ceased to operate, but those of the others mentioned continue to act and will do so until stability shall have been given to the banks. The work for this purpose, sloping and revetting, was not originally contemplated, but the necessity for it has become apparent, not only to keep the channel free from snags, but to give permanency to the improvement made.

It is thought that an aggregate length of 4 to 5 miles will cover the amount of bank revetment now needed.

The bars include all those that originally afforded a ruling depth of less than 2 feet. A deepening of 1 to 2 feet has been effected from scouring alone, induced by contraction of the channel. This contraction has not yet been less than 100 feet, and in most cases 125 feet.

In order to accommodate the coal tows from the Upper Warrior these widths should not be reduced. In straight reaches a channel laid along the bank with a width of 100 feet may suffice, but in bends and crossings the limit should not be less than 125 feet.

The improvements thus far made have lowered the navigable stage fully 3 feet. This has been practically demonstrated by a steamer which made the trip to Tuscaloosa and returned with 600 bales of cotton, on a stage hardly 2 feet above low water, the boat drawing at the time 4½ feet.

At the commencement of the present fiscal year it was found that, from long disuse, the plant belonging to this improvement was in a very unserviceable condition; a greater portion of the working season would have been consumed in procuring new outfit, contracting for supplies, etc. It was therefore deemed judicious and advantageous to defer all work until spring, with the expectation that Congress would make an additional appropriation, by which a much more efficient plant could have been procured and better work done. The act failing to become a law, and the plant being inadequate to the work proposed, authority was obtained to prosecute operations by contract.

Advertisements inviting proposals were published May 24 and bids opened June 9, 1887.

Only two bids were received, the lowest being John Maguire, of Mobile, Ala. No decision as to award had been reached at end of fiscal year.

The proposed improvement of the Black Warrior River above Tuscaloosa necessitates a modification of the existing project for the improvement of the river below Tuscaloosa, so as to accommodate a coal traffic not contemplated in original plans and estimates.

No detailed survey of this river has ever been made (only an examination and partial survey); it was therefore considered essential that a complete and thorough survey of the entire river from Tuscaloosa to its mouth should be made, whereon to base plans and estimates for greater width and depth of channel.

This survey was authorized and $1,800 from the appropriation was allotted for the work.

The survey was commenced on the 20th of May and at close of fiscal year had covered 30 miles of the river.

This, together with the care of the public property and the preliminaries for the contract work, constituted operations for the fiscal year ending June 30, 1887.

With the funds at present available it is proposed to remove, under contract, snags, logs, and other obstructions from the channel, and overhanging and leaning trees from the banks, commencing at mouth of the river, working up-stream as far as the appropriation will permit.

With open river navigation improved as proposed, it is expected that the river will afford safe and easy navigation throughout the year, though during the low-water period the depth afforded will be sufficient only for light-draught boats. For tows drawing 5 to 6 feet uninterrupted navigation may be expected for six months, with boating stages occurring irregularly for three months more.

This work, after completion, will require renewal, for some years at least, at a cost of $8,000 yearly.

The commercial advantages expected are—

First. The reduction of freight rates in consequence of competition between river and rail, amounting, as estimtaed in former reports, to $50,000 annually on the present business of the Warrior Valley.

Second. Doing away with the uncertainty, irregularity, and in great measure the risk heretofore attendant upon river transportation, and consequently reducing its cost.

Third. The utilization of the river as a channel for coal transportation to the Gulf.

Money statement.

July 1, 1886, amount available	$514.97
Amount appropriated by act approved August 5, 1886	18,750.00
	19,264.97
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,022.01
July 1, 1887, amount available	17,242.96
Amount (estimated) required for completion of existing project	34,714.62
Amount that can be profitably expended in fiscal year ending June 30, 1889	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

TOMBIGBEE.

The improvement of the Tombigbee in Mississippi was authorized by act of March 3, 1873, and its improvement below Columbus by act of March 3, 1875. Its continuance has been provided for by the following appropriations made for the Warrior and Tombigbee rivers jointly:

By act of March 3, 1873	$10,000
March 3, 1875	25,000
Aug. 14, 1876	15,000
June 18, 1878	40,000
Mar. 3, 1879	30,000
June 14, 1880	51,000
Mar. 3, 1881	26,000
Aug. 2, 1882	31,000
July 5, 1884	37,000
Aug. 5, 1886	37,500
Total	302,500

The act of July 5, 1884, made two divisions of the Tombigbee River, viz, "Fulton to Vienna" and "below Vienna." This distribution is accordingly observed in this report.

In its original condition the river was navigated throughout the year to Bladon Springs, the ordinary limit of tide-water, 143 miles from Mobile. During low water, however, the depth was sometimes reduced to 2 feet. Moreover, snags were troublesome, and at some points dangerous, so that they could be passed only in daylight.

From Bladon to Demopolis, 243 miles from Mobile, low-water navigation was difficult, both from bars on which the boats grounded and from snags and sunken logs. At times only 18 inches could be found on some of the bars, and then the boats turned back at Bladon.

From Demopolis to Columbus, 416 miles from Mobile, there were numerous bars, affording only 12 to 18 inches at low water, and the channel throughout was much obstructed by snags. Overhanging trees were troublesome on all stages of water, and often inflicted damage.

Navigation was carried on only in the winter and spring, the high-water season, and ceased when the river fell to a stage 4 to 6 feet above low water.

From Columbus to Aberdeen, 481 miles from Mobile, navigation was difficult on a 12-foot stage; to Cotton Gin Port, 516 miles, it was practicable for barges only, and to Fulton, 593 miles, there was no navigation at all.

The project adopted for improvement was to open a low-water channel of navigable width having a minimum depth of 4 feet to Demopolis and 3 feet thence to Columbus. From Columbus to Fulton the river was to be cleared of snags and overhanging trees for its improvement during the boating stages, open river navigation at low-water not being considered practicable.

The estimated cost of the improvement for the entire length of the river was $205,000.

The work was commenced in 1873, and the appropriation of $10,000 soon exhausted. It was not resumed until August, 1878, since which time, up to October 20, 1885, it has continued during low-water seasons for an annual average period of five months.

The time spent upon the work has been mainly devoted to snagging and bank trimming, which are essential preliminaries to bar improvement. A considerable amount of the latter work has also been done during the years in which funds available allowed the employment of a force for that purpose.

The result obtained under appropriations prior to that of August 5, 1886, is as follows:

First. From Fulton to Vienna.—From Fulton to Columbus, 177 miles, the proposed improvement has been completed, and the river is navigable down to a stage of 4 feet above low water. From Columbus to Vienna the river is navigable on a 2-foot rise for boats drawing 3 feet.

All of the river, except about 3 miles near Pickensville, has been well cleared of logs, of which 4,280 have been taken out. Twenty bars that originally afforded a depth of 12 to 20 inches, have been improved, and the depth increased to 3 feet. Fifteen bars of 18 to 24 inches depth remain unimproved and prevent low-water navigation.

Second. Below Vienna.—Four thousand one hundred and fifty-two snags have been removed and the banks well trimmed of overhanging timber. This work, together with the bar improvements made, have given safe navigation, with 3 feet depth at ordinary low water, to Demopolis.

Between Demopolis and Vienna fourteen bars have been improved, on eleven of which a depth of 3 feet has been secured. Fifteen bars below Demopolis and thirty above remain to be improved before the channel will have the desired depth. Until this is done the full benefit of the improvements made will not be felt.

The railroad bridge at Jones Bluff gives a difficult and unsafe passage for descending boats, in consequence of a projecting rock bluff above the bridge, which closes one draw-opening and throws a cross-current through the other.

No work was done on either section of the river during the fiscal year ending June 30, 1887, for the following reasons: The plant and outfit, from long service and from many months disuse, had become worn out and unserviceable, and the amount available did not justify the expenditure of the large amount required to procure new plant; it was, therefore, thought best to await action of Congress in expectation of a further appropriation.

The act failing to become a law and the funds on hand being insufficient both to supply new plant and prosecute operations, it was determined to do the work by contract.

Advertisement inviting proposals was published on May 24, and bids opened June 9, 1887. Three proposals were received for improvement from Fulton to Vienna, and two, for below Vienna. In both instances Mr. Peter Burke, of Mobile, Ala., was the successful bidder. The award had not been made at the end of the fiscal year.

Operations for the present fiscal year were confined to the care of the public property, to advertising for and opening proposals for the improvement of the river, so far as relates to section from Fulton to Vienna. On section below Vienna, in addition to the care and preservation of the public property, all necessary preparations were made, during the month of June, for commencing a survey of the river from Vienna to the mouth.

Two thousand five hundred dollars were allotted from the appropriation of August 5, 1886, for the purpose of making a complete and thorough survey of the river from Vienna to the mouth (only an examination and partial survey has heretofore been made), the object of the survey being to secure the necessary data whereon to base new project, plans and estimates for an increased width and depth, so as to accommodate a commerce different in its character from that contemplated when existing project was adopted, namely, the transportation of coal in barges.

The present amount available will be used during the fiscal year ending June 30, 1888, on section from Fulton to Vienna, in removing log obstructions and overhanging trees from Pickensville down stream, principally at "Shylock Bar," the most troublesome point on this part of the river.

Below Vienna.—In removing log obstructions and overhanging trees, commencing at "St. Nicholas' Point," about 100 miles above Mobile, working up-stream towards Vienna as far as the appropriation will permit.

Should Congress further appropriate before the end of the fiscal year bar improvements will also be included in the work.

The cost of the maintenance of the improvement when completed will be about $8,000 annually.

The immediate commercial advantage that may be expected upon the completion of the improvement will arise, not so much from the increased amount of business done upon the river, as from the reduction of freight charges on the whole traffic of the Tombigbee Valley. When the freight tariff shall have been regulated by competition between rail and river, maintained perennially, the advantage to the community of the improved river is to be measured by the amount of business affected by competition rates, and this will be all the transportation of the Tombigbee Valley, whether handled by river or rail.

Money statement.

Tombigbee River from Fulton to Vienna.

July 1, 1886, amount available	$123.03
Amount appropriated by act approved August 5, 1886	7,500.00
	7,623.03
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	171.74
July 1, 1887, amount available	7,451.29
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Tombigbee River below Vienna.

July 1, 1886, amount available	716.70
Amount appropriated by act approved August 5, 1886	11,250.00
	11,966.70
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,101.72
July 1, 1887, amount available	10,864.98
Amount (estimated) required for completion of existing project	12,858.38
Amount that can be profitably expended in fiscal year ending June 30, 1889	12,900.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 4.

IMPROVEMENT OLD TOWN CREEK, MISSISSIPPI.

The examination of this stream provided for by the provisions of section 3 of the river and harbor act of March 31, 1881, was made during the month of October, 1881, and report is contained in Annual Report of Chief of Engineers, Appendix K 29, 1881.

The condition of the creek when examined showed that the obstructions consisted entirely of accumulations of fallen trees, drift, and overhanging trees.

There were no shoals or rapids in the stream, and no artificial obstructions, except a bridge 6 miles below City Point.

Prior to the construction of the Mobile and Ohio Railroad boats ran to Camargo, 16 miles from the mouth, and in 1852 or 1853 a steamer ascended within 2 miles of City Point.

The project adopted is to obtain a high-water channel for four months in the year, say, from December 1 to May 1, from the mouth of the creek to City Point, a distance of 30 miles, the object being to secure a competing route for the transportation of plantation products and return supplies.

The estimated cost is $10,000. The river and harbor act of August 2, 1882, appropriated $3,000 for this improvement, but the appropriation was not made available until March 1, 1883.

Owing to continued high water, operations were not begun until July 2, 1883, and were suspended, on account of near exhaustion of funds, during the following September.

The result of the work was such as to permit a steamer to make three trips to Camargo, bringing out 800 bales of cotton and 200 sacks of cotton seed, carrying on her trips up 20 tons of supplies and farming implements.

About 500,000 feet of lumber in logs were floated down the stream to Columbus and Aberdeen.

As no appropriation has been made since, no further work has been done.

It is proposed to use any sum that may be appropriated in the future in continuing the removal of obstructions to high-water navigation, working as far up in the direction of City Point as the amount available will permit.

It is estimated that about 34,000 bales of cotton now transported by rail would naturally seek this route or be carried by rail at reduced rates, and that a saving of $1.50 per bale on present railroad freights would follow, thus securing to the community an annual saving of $50,000, and a corresponding reduction on return supplies of 80 per cent. on value of cotton.

No commercial statistics could be obtained for Old Town Creek; it is probably about the same as reported for the year 1883–'84.

Money statement.

Amount (estimated) required for completion of existing project	$7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 5.

IMPROVEMENT NOXUBEE RIVER, MISSISSIPPI.

The examination of this river provided for by act of Congress approved March 3, 1879, was made during the month of March, 1880, and extended from Macon, Noxubee county, Miss., to its mouth. Report is contained in the Annual Report of the Chief of Engineers for 1880. The condition of the river when examined was such that during all seasons of the year, and at all stages of water, navigation, except by small flat-boats, was practically impossible. Steam-boats prior to the building of the Mobile and Ohio Railroad (1859), plied this river. After the construction of this railroad the boats were withdrawn.

The river banks then became overgrown with timber, much of which in time fell or slid into the river and caused the formation of a number of shoals and bars. The river being virtually abandoned for the purposes of navigation, the planters living along its banks assisted in obstructing its channel-way by building a number of fish-traps and mill-dams.

The chief obstructions to navigation consisted in the immense number of trees overhanging the river throughout its entire length. At the time of the examination the minimum depth of the river was found to be (at ordinary low water) from 1½ to 2 feet, and the average width 60 feet. The project adopted was to afford a navigable channel for nine months in the year, from the mouth of the river to the town of Macon, by the removal of overhanging timber from the banks, and such obstructions to navigation as might be found in the river.

The estimated cost was $65,245.25.

The appropriations made for the improvement are as follows:

By act of Congress approved June 14, 1880	$12,000
By act of Congress approved March 3, 1881	8,000
By act of Congress passed August 2, 1882	10,000
By act of Congress approved July 5, 1884	7,500
By act of Congress approved August 5, 1886	7,500
Total	45,000

Work on this improvement was commenced during the low-water season of 1880; prosecuted during the fiscal years ending June 30, 1881, and June 30, 1882, and through the month of March, 1883, when the appropriations being about exhausted, operations were suspended.

Work was resumed, under the appropriation of $7,500 made by act approved July 5, 1884, in September, 1884, and continued until January 12, 1885, when high water and extreme cold weather compelled a suspension of the work.

On May 23, 1885, operations were again resumed and continued until September 23, 1885, when work was suspended for want of funds.

Work during the present fiscal year was resumed May 20, 1887, at a point about 40 miles above the mouth of the river, and at the close of the year had reached a point 8 miles higher up—48 miles from mouth of river. Three (3) miles of this distance was wholly improved, and 5 miles partially.

The amount of work done during the fiscal year is itemized as follows:

Quarter-boat repaired	1
Snags, logs, and stumps removed	750
Trees cut	250
Overhanging limbs cut	135

The condition of the improvement at the end of the fiscal year is a partially improved channel the entire distance from the mouth of the river up to Macon, and wholly from Macon to a point 28 miles below, and from the mouth to a point 30½ miles above, giving a river 58½ miles wholly and 33 miles partially improved.

The amount available for fiscal year ending June 30, 1888, will be expended in continuing the improvement up-stream as far as funds will permit.

On completing the improvement as designed the river during high-water season will be navigable from its mouth to Macon, thus furnishing a new and cheaper transportation route for the planters along or adjacent to the river for their cotton, produce, and supplies, the greater portion of which is now hauled over heavy prairie roads long distances to the different stations on the Mobile and Ohio Railroad.

The work is not susceptible of permanent improvement, and will require an annual expenditure cf at least $3,000 to maintain it in its improved condition. The reduction in freight charges on cotton and produce that will naturally follow the opening of this river for navigation is estimated at about $20,000 per annum.

A corresponding decrease in the freight charges will also be felt in all lines of goods and merchandise transported, owing to the discrimination made between through and local rates by railroads. The shipments over the river may possibly be also increased by the improvement, furnishing the means of supplying coal to the inhabitants living near the river from the coal-fields of the Sipsey and Warrior rivers.

Efforts have been made to obtain commercial statistics, but without success.

Money statement.

July 1, 1886, amount available	$162.51
Amount appropriated by act approved August 5, 1886	7,500.00
	7,662.51
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,342.46
July 1, 1887, amount available	6,320.05
Amount (estimated) required for completion of existing project	20,245.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 6.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

In 1873 a plan for the improvement of the river at its mouth by dredging a channel 100 feet wide and 8 feet deep at mean low water, with jetties on each side, was submitted by Lieut. James B. Quinn, Corps of Engineers, but owing to legal complications as to the ownership of what was then known as the "Noyes Canal," nothing was done under the plans and specifications then submitted. In 1878, all fear of legal complications having been removed, an examination of the river was made under an allotment of $1,500 from the appropriation of $10,000 made by act of Congress, June 18, 1878, for the improvement of the river.

The plan adopted for the improvement was the dredging of a channel 200 feet wide and 7 feet deep at mean low water through the bar at the mouth of the river, and the removal of snags and overhanging trees throughout its entire length, at an estimated cost of $53,800.

At the commencement of the work there were from 3 feet to 3½ feet on the bar at mean low water, and the river was much obstructed by snags, logs, and overhanging trees. The following appropriations have been made:

By act June 18, 1878 ($1,500 for examination)	$10,000
Mar. 3, 1879	14,000
June 14, 1880	20,000
Mar. 3, 1881	4,000
Aug. 2, 1882	8,000
July 5, 1884	3,000
Total	59,000

From the aggregate amount of the several appropriations above mentioned, less $1,500 allotted for examination, $42,500 was devoted to dredging through the bar at the mouth, and resulted in securing a channel through the bar 180 feet to 190 feet wide, 7½ to 8 feet deep, enabling vessels to go up to the mills at Moss Point and load, thus saving large lighterage bills and claims for demurrage.

Statement of dredging operations under the above appropriations.

Date of act.	Name of contractor.	Time of commencement.	Time of completion.	Contract price.	Number cubic yards removed.
				Cents.	
June 18, 1878 Mar. 3, 1879	S. N. Kimball	July 18, 1880	Jan. —, 1881	$32\frac{44}{100}$	63,000
June 14, 1880	W. G. Mitchell	Mar. —, 1881	Mar. —, 1882	27	118,996
	Total				181,996

Fifteen thousand dollars of the total amount appropriated was applied to the removal of snags, logs, and overhanging trees.

Commencing at the light-house near the mouth of the river, in the spring of 1882, the work was prosecuted during the working seasons of 1882, 1883, and 1884. This portion of the work was completed on December 23, 1884.

The result of the work has been to secure a navigable channel from the mouth of the river to one-half mile above "Dead Lake," 50½ miles, for vessels drawing 6½ feet, and to the junction of the Leaf and Chichasaha for vessels of lighter draught, during six or eight months of the year.

The river and harbor act of August 5, 1886, made a further appropriation of $20,000 for continuing the improvement including the bar at the mouth, and directed that the balance of the money now on hand, heretofore appropriated for improving Horn Island Pass, be applied to the same purpose.

These combined amounts, together with a small balance remaining from former appropriations, afforded the sum of $25,113 available for work during the fiscal year ending June 30, 1887.

The new project adopted is the securing of a channel of navigable width and minimum depth of 12 feet from Moss Point to the anchorage in the bay, at an estimated cost of $78,100, and maintaining the river above Moss Point in its improved condition.

On September 2, 1886, a project for the expenditure of the amount available was submitted and approved October 29, 1886; $2,500, or as much as might be necessary, was to be expended in removing snags and overhanging trees in the river (preservation of improvement already obtained). The balance available (to be applied to dredging) was not believed to be sufficient for economical or efficient work in carrying out the new project. Authority, therefore, was obtained to defer the dredging of the channel until a further appropriation had been made. It was deemed advisable to make a more complete survey than the one already made for the purpose of laying out the channel proposed to be dredged at the mouth of the river.

This survey was authorized, and $900 allotted for the work. It was commenced May 21, 1887, and field work completed June 22, 1887. The work during the fiscal year ending June 30, 1887, was confined to the making of the above-mentioned survey. The plant being in an unserviceable condition, and the condition of the river being good, no snagging was done.

It is proposed to expend such funds as may be available for the fiscal year ending June 30, 1888, in securing, by dredging, a channel of navigable width and as deep as the amount available will permit, not exceeding 12 feet, through the bar at the mouth, and in removing such logs, etc., from the river, from Moss Point to Dead Lake, as may have lodged during the suspension of the work.

Since the beginning of the work of improvement large sales of Government and State lands adjacent to the river have been made to capitalists, and the continuance of the work will offer further inducements for the development of the resources of this richly-timbered section. The improvement, even in its incomplete state, has already been of great benefit to the country depending for its trade upon the navigation of this river.

This improvement will not be permanent in its character; $2,500 will be required annually for the removal of snags in order to maintain the river above Moss Point in its present improved condition—the annual amount necessary to preserve the dredged channel can not at present be estimated.

Money statement.

July 1, 1886, amount available	$113.37
Amount appropriated by act approved August 5, 1886	25,000.00
	25,113.37
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,508.12
July 1, 1887, amount available	23,605.25
Amount (estimated) required for completion of existing project	54,494.75
Amount that can be profitably expended in fiscal year ending June 30, 1889	55,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Statistical statement of commerce of the port of Pascagoula, Miss., for fiscal year ending June 30, 1887.

Vessels.	Entrances.		Clearances.	
	No.	*Tons.*	*No.*	*Tons.*
Foreign	85	41,253	88	52,008
American	134	26,932	173	38,374
Coastwise	98	13,682	135	27,113
Total	317	81,867	396	117,495

Fees	$747.34
Duties on imports	369.91
Tonnage dues	1,295.64
Hospital collections	208.00
Total	2,620.89
	Value.
Exports	$389,515.00
Imports	2 093.14

The following is the approximate trade, including both foreign and coastwise.

75,000,000 feet lumber, at $12 per M	$900,000
700,000 barrels charcoal, at 11 cents	77,000
1,250 barrels turpentine, at $12.60	15,750
5,000 barrels rosin, at $2	10,000
800,000 shingles, at $3 per M	2,400
Miscellaneous, bricks, hides, tallow, country produce	2,000
Total	1,007,150

Q 7.

IMPROVEMENT OF HARBOR AT BILOXI BAY, MISSISSIPPI.

The examination of this roadstead, provided for by the third section of the river and harbor act of March 3, 1881, was made during the months of August and September, 1881.

The report is contained in Annual Report of Chief of Engineers, 1882, Appendix K 27.

The examination showed that between the roadstead and the Back Bay are situated a series of mud flats called "Deer Island Flats," about 1¼ miles east of Biloxi, having a present depth of 4 feet.

The improvement understood to be desired was to secure through these flats a channel 8 feet deep.

The estimated cost of the work by dredging was $35.000.

The act of Congress, August 2, 1882, appropriated $5,000 for the improvement of the roadstead.

No project was submitted, the amount appropriated being deemed insufficient for an economical prosecution of the work; authority was therefore obtained to defer all action until a further appropriation was made.

The act of July 5, 1884, directed that the balance of the money heretofore appropriated for the roadstead be applied to the deepening of the channel from Mississippi Sound to the wharves of Biloxi.

An examination was made of this locality in the months of August and September, 1881, and report is contained in Annual Report of Chief of Engineers, 1882, Appendix K 27.

The desired improvement, as indicated by the examination, was the deepening of the channel from Mississippi Sound to the wharves of Biloxi from 4½ feet, the least depth at that time, to 8 feet, and the estimated cost was $55,000.

It was not deemed economical or judicious to commence the work with the small amount on hand. Authority was therefore obtained to hold the appropriation until a further one was made to justify a call for bids.

The river and harbor act of August 5, 1886, appropriated $12,500, thus affording, with the balance on hand, the sum of $17,488.55 for carrying on the work of improvement.

The plans and estimates heretofore submitted were based upon an examination only (not sufficient for laying out the work properly), the limit of time and money preventing a complete survey; therefore a careful survey of the channel from Mississippi Sound to the wharves of Biloxi, to locate channel to be dredged, was recommended to be made

This recommendation was approved, and $900 from amount available was allotted for the work.

This survey was made during the months of April and May, this year. Projects and estimates will be submitted early in next fiscal year.

This constituted the work on this improvement during the fiscal year ending June 30, 1887.

The amount on hand and such sum as Congress may appropriate will be applied to prosecuting the improvement in accordance with such project as may hereafter be adopted.

Money statement.

July 1, 1886, amount available	$4,988.55
Amount appropriated by act approved August 5, 1886	$12,500.00
	17,488.55
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	964.91
July 1, 1887, amount available	16,523.64
Amount (estimated) required for completion of existing project	37,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	37,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS BILOXI HARBOR, MISSISSIPPI.

The present annual commerce of Biloxi is approximately estimated as follows:

4 canning factories, employing seven hundred and fifty employés	$167,793.40
4,000 feet of lumber, at $11	44,000.00
4,500 cords of wood, at $1.40	6,300.00
1,500,000 bricks, at $9	13,500.00
275,000 laths, at $1.25	343.75
Wool and hides	24,000.00
Potteries, fullers earth	7,500.00
Poultry	10,000.00
Charcoal	35,000.00
Oysters (bulk and shell)	30,000.00
Fish (fresh and salt)	22,000.00
Total	360,437.15
Imports, general merchandise	350,000.00
Total	710,937.15

One hundred and thirty-seven light-draught schooners are engaged in the coastwise trade, carrying chiefly oysters, charcoal, wood, pottery, and fullers earth.

The increase of commerce likely to ensue from the completion of this improvement would be impossible to estimate at present.

Q 8.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN EDINBURGH AND CARTHAGE.

A survey of this part of Pearl River was made under direction of Maj. Amos Stickney, Corps of Engineers, U. S. Army, during the month of November, 1883.

The original project for the improvement of this part of the river is to afford a high-water channel from Edinburgh to Carthage, a distance of 24¾ miles, for six or eight months of the year, at an estimated cost of $13,464.

There is no navigable channel in the greater portion of this part of the river during low water. Although high banks are found on both sides of the river, yet the river is so obstructed by fallen trees, snags, roots, logs, sand, and mud-bars and overhanging trees that navigation by the steamer *O. R. Singleton*, built for this trade in 1883, was only possible during very high water.

The following appropriations have been made:

By act of July 5, 1884	$2,500
By act of August 5, 1886	2,250
Total	4,750

Under the appropriation of $2,500 made by act of July 5, 1884, work on this part of the river was commenced at Edinburgh on the 17th of November, 1884, and continued until the 23d of January, 1885, when the river becoming too high for working to advantage, operations were suspended.

Nineteen miles of this part of the river were partially improved.

On the 3d of September, 1885, operations were resumed. Commencing 19 miles below Edinburgh, the work was carried down to Cathage, 5¾ miles. Such stumps, roots, logs, and trees as were found most in the way were removed by cutting and blasting.

On September 30, 1885, the appropriation being nearly exhausted, operations were suspended, and the plant and property stored at Edinburgh.

Under the appropriation of $2,250, made by act of August 5, 1885, operations were resumed on November 16, 1886, and carried downstream 20¾ miles, within 4 miles of Carthage. Only the most dangerous and troublesome obstructions were removed, however, the object being to render as great assistance to steam-boat navigation during the present boating season as possible.

On account of high water and cold weather, work was suspended on the 18th of December, 1886, and has not since been resumed, as it was deemed advisable to defer all work until such a time as would allow operations to be prosecuted uninterruptedly.

The method of improvement is the removal of obstructions from the channel and clearing of the banks of overhanging trees by hired labor and purchase of material by contract.

SUMMARY OF WORK DONE DURING THE FISCAL YEAR.

Snags removed	588
Stumps removed	265
Logs removed	290
Overhanging trees removed	760

Owing to the continual washing of banks, causing trees to fall in, the improvements made will not be permanent. It is estimated that an annual expenditure of $500 will maintain the river in the condition contemplated by the plan of improvement.

Considerable benefit was derived from the work so far done, as shown by the fact that before the improvement the time consumed by the steamer ascending the river from Carthage to Edinburgh averaged six days, while after the improvement the steamer made several trips in twelve hours.

The condition of the improvement on June 30, 1887, was such as to allow boats of 3½ feet draught of water to navigate the river between Edinburgh and Carthage with comparative safety on a rise of 5 feet above ordinary low water.

Before the improvement most of the produce and merchandise had to be hauled by wagons between Edinburgh and railroad stations, generally a distance of from 30 to 60 miles.

The reduction and saving in railroad freights by river competition, due to the improvement, is considerable, as shown by the following exhibit:

Freight on a barrel of flour from New Orleans delivered at Edinburgh was, before the improvement, $2.10; now it is 75 cents.

The saving on a ton of fertilizer is $5; on a bale of cotton, $4.

It is estimated that the aggregate saving in freights and insurance annually to the farming interests of the counties adjoining the river, due to the improvement, will not fall short of $30,000.

The rate of insurance both up and down stream has been reduced nearly one-third.

Only one boat—the steamer *O. R. Singleton*—has been employed on this section of the river during the fiscal year.

Her dimensions are, length, 95 feet; tonnage, 110; draught of water, 4½ feet.

Owing to almost continuous low water during the year this steamer could only make one trip to Jackson and return, carrying on her down trip 500 bales of cotton, valued at $25,000; bringing back on her return trip 100 tons of general merchandise, etc., valued at $20,000. Five thousand saw logs were carried down the river, valued at $10,000.

Money statement.

July 1, 1886, amount available	$0.55
Amount appropriated by act approved August 5, 1886	2,250.00
	2,250.55
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,137.04
July 1, 1887, amount available	1,113.51
Amount (estimated) required for completion of existing project	10,964.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 9.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, FROM JACKSON TO CARTHAGE.

An examination of this part of the river was made under direction of Capt. C. W. Howell, Corps of Engineers, U. S. A., in 1879.

The original project for the improvement of this part of the river consisted in the removal of snags, logs, and overhanging trees, and was to afford a clear channel of navigation 5 feet deep at a low stage of river from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

This amount is not sufficient to clear the river of obstructions so as to give safe navigation during a low stage of water. The original estimate should be increased $29,000.

The reason for the increase in the expenditure over the original estimate is that the examination was made at a high stage of water, when many of the obstructions could not be seen, and the estimates were based on the report of the examination.

The following appropriations have been made:

By act of Mar. 3, 1879	$6,000
June 14, 1880	7,500
Mar. 3, 1881	2,500
Aug. 2, 1882	2,500
Aug. 5, 1886	2,250
Total	20,750

Under the appropriation of $6,000 made by act of March 3, 1879, a contract was entered into with J. S. Hamilton, November 20, 1879, for the improvement of this part of the river.

Under the appropriation of $7,500 made by act of June 14, 1880, another contract was made with J. S. Hamilton to continue the work.

Under the appropriation of $2,500 made by act of March 3, 1881, after due advertisement no bids were received, and the amount was allowed to stand awaiting further appropriations sufficient to warrant commencement of work.

Under the appropriation of $2,500 made by act of August 2, 1882, a project was submitted August 17, 1882, to continue the work by hired labor, which was approved.

The work under the Hamilton contract did not prove satisfactory and the contracts were annulled September 22, 1882.

On July 8, 1884, the work was, in accordance with instructions from the office of the Chief of Engineers, U. S. Army, transferred by Maj. Amos Stickney, Corps of Engineers, U. S. Army, to Maj. A. N. Damrell, Corps Engineers, U. S. Army, and the improvement was carried continuously down-stream to a point 12 miles below McFadden's Ferry, at Carthage.

In the balance of the river down to Jackson only the worst and most dangerous places were partly improved.

In January, 1885, the appropriation being exhausted, the derrick and quarter boats were carried down-stream to Wakiah Bluff, the boats and machinery overhauled, and the boats laid up to be used on the improvement of the river below Jackson.

Under the appropriation of $2,250 made by act of August 5, 1885, work was resumed in January, 1887, by hired labor and purchase of material by contract.

Commencing at Carthage, work was prosecuted down-stream to Partin's Bluff, 46 miles below.

The improvement was only partial, the object being to remove only such obstructions as were the most troublesome to navigation during the next boating season.

A rise in the river on the 29th of January compelled a suspension of the work, and it was deemed to be to the best interest of the Government to defer all work until such a time as would allow operations to be prosecuted uninterruptedly.

SUMMARY OF WORK DONE DURING THE FISCAL YEAR.

Number of snags removed	323
Number of sunken logs removed	201
Number of overhanging trees removed	216
Number of stumps removed	197

Before the improvement, even during high water, steamers could not make more than two trips a month between Jackson and Carthage, while since the improvement boats make four and five trips a month.

The condition of the river on June 30, 1887, was as follows:

Boats of 3-foot draught of water can navigate with comparative safety at a stage of 4 feet above low water from Carthage down to Partin's Bluff, a distance of 46 miles; the remaining distance down to Jackson, 59 miles, can only be navigated on a 6 or 7 foot rise.

Owing to caving in of banks and shifting of the channel, the improvements so far made and contemplated will not be permanent; an annual expenditure of $2,400 would maintain the river in the condition contemplated by the plan of improvement.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,250.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	269.40
July 1, 1887, amount available	1,980.60
Amount (estimated) required for completion of existing project	29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	29,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Vessels navigating on Pearl River, Mississippi.

Name of vessel.	Description.	Length.	Beam.	Draught.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
O. R. Singleton	Stern-wheel	95	23	4½	110
Dora	Propeller	35	8	8	....
2 flat-boats	Towing	75	18	3	....

Statement of staple articles transported on river.

UP-STREAM.

Articles.	No.	Value.
	Tons.	
Grain	160	$4,800
General merchandise	150	80,000
Fertilizers	60	1,500
Total	....	36,300

DOWN-STREAM.

Cotton ..... bales	500	$25,000
Staves	11,000	400
Lumber ..... feet	25,000	2,500
Firewood ..... cords	1,200	4,800
Saw-logs	5,000	10,000
Total	....	42,700

Before the improvement most of the produce and merchandise had to be hauled between Carthage and other landings on the river and the nearest railroad stations, generally a distance of from 25 to 40 miles.

The reduction and saving in railroad freights by river competition, due to the improvement, is considerable, as shown by the following exhibit:

Freight on a barrel of flour from Jackson, Miss., delivered at Carthage, was $1.80 before the improvement; now it is 50 cents.

The saving on a bale of cotton down stream is $3.50; on a ton of fertilizer, $5.

The rate of insurance on freights, both up and down stream, has also been considerably reduced; the exact reduction, however, could not be ascertained.

Q 10.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BELOW JACKSON.

The original project for improving this part of the river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep at low water from Jackson down to the mouth by the removal of snags, stumps, roots, and sunken trees, and the clearing of the banks of overhanging trees, at an estimated cost of $95,940, based upon the report of a survey made under direction of Capt. C. W. Howell, Corps of Engineers, U. S. Army, by Mr. H. C. Collins, assistant engineer in charge, in March and April, 1879, at a stage 10 feet above low water.

Congress, by act approved July 5, 1884, included the bar at the mouth of the river (East Pearl), the rough estimate of the cost of improvement of which is $20,000.

The following appropriations have been made:

By act of June 14, 1880	$30,000
By act of Mar. 3, 1881	25,000
By act of Aug. 2, 1882	15,000
By act of July 5, 1884	10,000
By act of Aug. 5, 1886	13,125
	93,125

After due advertisement a contract was entered into, October 7, 1880, with S. N. Kimball, for the improvement of 196 miles of the river from Jackson down.

Owing to high water the contractor was unable to complete his work within the time specified, January 1, 1882, and an application for extension of time to January 1, 1883, was approved.

Under the appropriation of $25,000, made by act of March 3, 1881, a project for the expenditure of this amount was submitted and approved.

After due advertisement a contract was entered into with G. A. Meyers for the improvement of 100 miles more of the river, commencing at a point 195 miles below Jackson, the end of Kimball's work.

On July 27, 1882, the work was reported finished, but an inspection showed that it was not in accordance with specifications, and the contractor resumed work.

August 23, 1882, the work was accepted.

Two hundred and ninety-five miles of this part of the river were somewhat improved, and there remained from 15 to 20 miles of bad river near the mouth upon which no work had been done.

Under the appropriation of $15,000, made by act of August 2, 1882, the amount was to be expended under the supervision of the United States Engineer Office by hired labor.

In November, 1883, the work was, for various reasons, suspended; a watchman was placed on the plant to take care of the property.

The work accomplished by hired labor was the closure of 12 runout bayous by levees and piling, the cutting of 120 snags, and the girdling of 700 trees on the banks.

Under the appropriation of $10,000, made by act of July 5, 1884, the work on the improvement of this part of the river was continued by hired labor till September, 1884.

In accordance with instructions from the Chief of Engineers, U. S. Army, dated Washington, D. C., July 8, 1884, this work was transferred by Maj. Amos Stickney, Corps of Engineers, U. S. Army, to Maj. A. N. Damrell, Corps of Engineers, U. S. Army.

The sum of $5,154.83 was transferred by Major Stickney.

Ten thousand dollars, appropriated by act of Congress, approved July 5, 1884, was also available, making a total on hand at the transfer of $15,154.83.

From September to 1st of December, 1884, operations on this part of the river were suspended, and a watchman was employed to take care of the property.

Work was again commenced December 1, 1884, and continued, whenever the stage of water permitted working to advantage, to the 30th of June, 1885, at which time the condition of the improvement was as follows:

Two hundred and ninety-five miles of this river, from Jackson down to Poitevant's Bluff, had been partially improved by contract. Fifteen miles of this distance, from the head of West Pearl River down to lower end of Homes Bayou, had been reworked by hired labor, but the improvement had not been completed.

During the fiscal year ending June 30, 1886, operations were continued from the 30th of June, 1885, to March, 1886, at which time the appropriation was almost exhausted.

A watchman was placed on the plant to take care of the property.

Under the appropriation of $13,125 made by act of August 5, 1886, operations on this part of the river were resumed September 5, 1886.

The plant was thoroughly overhauled and put in good working condition.

The work consisted in completing the cut-off near the head of West Pearl River, and the full improvement of the river from the cut-off down to the New Orleans and Northeastern Railroad Bridge, a distance of 30 miles; 5 miles, of river, from Middle River down to Indian Village, were fully improved by clearing the banks of overhanging trees, no other work being necessary.

From June 16 to June 30, 1887, preparations were made for constructing a temporary pile-driver for closing Farr Slough and collecting a number of willow piles and brush.

The following is the summary of work performed during the fiscal year:

	Number.		Number.
Snags removed	1,076	Overhanging trees removed	9,346
Stumps removed	1,272	Trees deadened	1,531
Roots removed	763	Cords willows planted	178
Sunken logs removed	1,446	Running yards cane removed	1,584
Sunken trees removed	1,070	Cubic y'ds clay and sand removed	1,628

The timbers and sides of the old Confederate gun-boat *Arrow* were cut down to dead low-water level, and a large amount of drift and brush were removed.

The condition of this part of the river has been greatly improved by the work done, particularly the river below the cut-off near the head of West Pearl River and Homes Bayou, which before the improvement had always been considered the most dangerous and troublesome portion of the whole river.

The cut-off near the head of West Pearl River is now in a perfect condition for navigation, the river from the head of the cut-off down to the head of West Pearl is shoaling rapidly, and that portion from the head of West Pearl down to the lower end of the cut-off is entirely dry at a 3-foot rise above ordinary low water; four-fifths of the volume of water from the main river above now enters the cut off, and consequently that portion of the river immediately below the cut-off, where there used to be sand-bars and shoals, has now an uniform depth of 5 feet at an ordinary low stage of river.

Light-draught boats can now navigate the river from the mouth, at the Rigolets, to the head of the cut-off, 51 miles, all the year round, and to Columbia, 158 miles, and Monticello, 214 miles, at a 5-foot rise above low water six months in the year.

The condition of the river above the cut-off as far as Jackson, Miss., is about the same as when left by the contractors in 1883, no work having been done there since, and can be navigated only safely on a 6 or 7 foot rise.

The benefits derived by the improvement of the river effected up to June 30, 1887, are, greater security to navigation between New Orleans, La., and Columbia and Monticello, Miss., and reduced freights and insurances on merchandise and produce.

A large proportion of the cotton, merchandise, etc., were before the improvement hauled from Columbia, Monticello, and other towns and settlements located on the river, to the nearest railroad stations on the Illinois Central and New Orleans and Northeastern railroads, a distance of from 20 to 40 miles.

Freight on a bale of cotton shipped in this way to New Orleans, La., was $4.80, on a barrel of flour, $2.

Freight on a bale of cotton shipped down the river from Columbia, Miss., delivered at New Orleans, La., costs now $1 per bale, a barrel of flour 50 cents, other freights in proportion.

This shows there is a very large reduction and saving in freights by river competition by the improvement of the river.

It is proposed to apply the amount available, and any appropriation that may be made for the next fiscal year, to the closing effectually of Farr Slough, and to the improvement of the river above the cut-off towards Jackson, Miss., as far up as the amount available will permit.

In addition to the improvement of the river proper the increased lumber trade of the mills situated on the river, particularly that of Messrs. Poitevant and Faroe at Pearlington, Miss., located about 12 miles above the mouth of East Pearl River, demands the deepening of the bar at the mouth by dredging.

Vessels of 7 feet draught of water can be loaded at the mills on the river, but the lumber for vessels of heavier draught, of which there are a large number loaded by the mills, must now be lightered and towed over the bar, which not only causes great delay, but heavy expenses.

It is desired by mill-owners and those interested in the lumber business on the river to obtain a 12-foot channel over the bar.

After vessels cross the bar there is sufficient water up to the mills to load down to 12 feet.

The estimated cost of dredging a channel 12 feet deep at mean low tide over the bar at the mouth of East Pearl River is $20,000.

Owing to the caving-in of banks after freshets, as also to the shifting of the channel, the improvements so far made and contemplated will not be permanent.

An annual appropriation of $5,000 would be sufficient to maintain the river in the condition contemplated by the plan of improvement.

The amount asked for this work is in excess of the original estimate. The reasons are as follows:

I. The survey of the river upon which the original estimate was based was made at a stage 10 feet above low water; the result was a decided underestimate of the amount of work and cost.

II. A large portion of the work was done by contract, and so done by the contractors as to require reworking.

III. The obstructions forming each year of snags, sunken logs, and trees and overhanging trees requiring removal, were not included in the original estimate, but are included up to date in the proposed modification of existing project.

The extent of the anticipated excess is $50,000.

Commercial statistics from the saw-mills located on the river could not be obtained in time, but will be forwarded as a supplementary report.

Owing to the unprecendented and continuous low water during almost the entire year, steamers navigating the river up to Columbia and Monticello, Miss., were unable to make their usual number of trips. The shipments of cotton down-stream and merchandise up-stream are therefore less than those of last year.

Money statement.

July 1, 1886, amount available	$1.45
Amount appropriated by act approved August 5, 1886	13,125.00
	13,126.45
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	8,308.95
July 1, 1887, amount available	4,817.50
Amount (estimated) required for completion of existing project	70,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Statement of vessels employed on Pearl River below Jackson.

Character of vessels.	Number.	Tonnage.
Steam-boats	6	590
Schooners	8	350
Flat-boats	4	130

Statement of staple articles transported on Pearl River below Jackson, to and from New Orleans, La., and saw-mills near mouth.

DOWN-STREAM.

Articles.	Quantity.	Value.
Cotton ... bales	2,000	$100,000
Rice ... barrels	1,400	14,000
Turpentine ... do	1,000	12,000
Resin ... do	3,000	5,000
Staves ... number	10,000	2,000
Fire-wood ... cords	4,000	16,000
Fowls and eggs ... dozen	1,200	2,000
Saw logs, pine ... number	280,000	560,000
Saw logs, cypress ... do	6,000	24,000
Total	....	735,000

Statement of staple articles transported on Pearl River below Jackson, etc.—Continued.

UP-STREAM.

Articles.	Quantity.	Estimated value.
Fertilizers ... tons	1,400	$300,000
Grain ... do	500	
Machinery ... do	90	
General merchandise ... do	10,000	
	11,990	

Q 11.

PRELIMINARY EXAMINATION OF NOXUBEE RIVER, MISSISSIPPI, TO ASCERTAIN WHETHER IT CAN BE MADE CONTINUOUSLY NAVIGABLE BY A SYSTEM OF LOCKS AND DAMS, OR OTHERWISE.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 9, 1887.

SIR: I have the honor of submitting the following report concerning the preliminary examination of the "Noxubee River, Mississippi, to ascertain whether it can be made continuously navigable by a system of locks and dams" provided for by river and harbor act, August 5, 1886.

A careful examination of this river was made from its mouth up to Macon, Miss., in November and December, 1879, report of which is contained in Annual Report of Chief of Engineers for 1880, part 2, from which it appears that such an improvement as was warranted by the present commerce, or what would be probably developed in the near future, could be made at an estimated cost of about $65,000, with $3,000 per annum afterward for preserving improvement.

The improvement suggested was to remove snags, logs, and overhanging trees so as to give a good high-water channel. The greater portion of the work has already been completed.

Some use has already been made of the river by steam-boats.

The only other system of improvement is by locks and dams, and in my opinion the river is not worthy of improvement in that way on account of the great cost and the comparatively small amount of commerce to be benefited.

The fall in the river is approximately 47 feet. The low-water discharge is very small.

The river in its upper portion has an average width of only 60 feet, contracted in places to less than 40 feet width for low-water channel.

The only gain would be the extension of the boating stage on the river three or four months.

The only commerce to be benefited by an improvement of the river would be the shipment of less than 20,000 bales of cotton and about the same value of return supplies, now moved on the Mobile and Ohio Railroad; the saving of freight on which has been estimated at about $20,000 per annum.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX R.

INSPECTION OF THE IMPROVEMENT AT THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJOR W. H. HEUER, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 1, 1887.

GENERAL: I have the honor to submit my report for the fiscal year ending June 30, 1887, upon the improvement of the South Pass of the Mississippi River.

The body of the report and charts were prepared by Mr. O. Donovan, the able assistant engineer in local charge of the surveys and examinations.

The salient features of the report are that, with the exception of three days during the month of March, 1887, when there was some temporary shoaling in the Pass, about 1⅜ miles below its head, there has been throughout the fiscal year a channel from the river into the jetties, having a navigable depth of 26 feet. Between the jetties, and out to deeper water in the Gulf, there has been during the entire year a 26 foot deep channel not less than 200 feet wide at bottom, containing a 30-foot deep channel of variable width.

No dredging has been done in the jetties or Pass, or vicinity, since February, 1883.

The most important and beneficial change that has occurred during the year is that a good, straight channel was secured in October, 1886, in the prolongation of the axis of the jetties, probably caused by the completion of the inner jetties and a long period of high water, with rapid current in the river, which produced a scour and widened and deepened what had been a very unsatisfactory channel. This new channel is 210 feet wide, 26 feet deep; it has a central depth of 30 feet, which is 60 feet wide in its narrowest place.

The crooked, deep channel beyond the outer end of East Jetty is still in existence; the 26-foot channel is 260 feet wide, and the 30 foot channel is 170 feet wide.

In the fan-shaped area beyond the ends of the jetties there has been during the year a deposit of sediment averaging 1.38 feet in depth. As this area embraces about 1¼ square miles, the aggregate fill on this area has amounted to about one and three-quarter millions cubic yards of material.

During the year several steamers drawing less than 26 feet have been aground in the Pass and near the jetties; surveys made as soon as practicable afterwards showed in every instance that the vessels were not in the channel.

The changes in depths and widths which have happened in the Pass and jetties are those of ordinary occurrence. In some localities the channel has deepened, in others shoaled. The shoaling has generally occurred in the deeper parts of the Pass, and was not detrimental to navigation. Profile chart No. 6 shows these changes fully. Below the head of the Pass one new wing-dam of piles, brush, and stone was built, another was repaired, and extended further into the Pass. Nearly all the old wing-dams near Grand Bayou were strengthened or repaired.

A violent storm last October did considerable damage to the superstructure of the outer jetties. The details are described in Mr. Donovan's report. The diagrams showing the scour and fill in the fan shaped area just outside of the jetties are very interesting and instructive. They show the greater portion of the sediment is dropping at distances a little more than half a mile outside the jetties, and principally to the right and left of the prolongation of the axis of the jetties.

The act of Congress of March 3, 1875, making provision for the construction and maintenance of the jetties provides that—

> Payments shall be made on certified statements of an engineer officer, who shall be detailed by the Secretary of War, and whose duty it shall be to report the depth of water and width of channel secured and maintained in said channel from time to time, together with such other information as the Secretary of War may direct.

The condition of the channel can only be obtained by actual surveys which are made continuously, and results are reported monthly.

The expenses of the surveys have heretofore been paid from funds appropriated by Congress in the river and harbor bills. When such bills failed the working force was not paid in one instance for seven months, until relieved by a deficiency bill. The failure of the last river and harbor bill to become a law, and no special provision having been made by Congress to pay for the continuance of the required surveys at South Pass, leaves the work in the anomalous condition of requiring by law that the surveys and examinations be made, but makes no provision for their payment. This renders the surveys liable to cease as soon as the present available funds are exhausted, which will be at the end of August, 1887.

It is believed to be for the best interests of the Government that special appropriations be made for continuing this work in compliance with law, instead of being dependent annually on the passage of a river and harbor bill.

Special attention is invited to the necessity of authorizing the enforcement of rules and regulations for the navigation of South Pass. The present rules as sanctioned by the Secretary of War are sufficient, but have no legal force and therefore can not be enforced.

It will be necessary to drive about 100 piles along the east bank of the Pass to which to moor vessels to prevent their being blown or swinging across the Pass, which is only about 700 feet wide. The estimated cost of this work is $1,000.

Capt. James B. Eads, who built the South Pass jetties, died March 8, 1887.

This important engineering work is a fitting monument to his skill and ability.

ESTIMATE OF FUNDS REQUIRED FOR EXAMINATIONS AND SURVEYS AT SOUTH PASS OF THE MISSISSIPPI RIVER, DURING THE FISCAL YEAR ENDING JUNE 30, 1889.

2 assistant engineers	$4,500
1 recorder	1,200
1 steam engineer	1,200
1 water-level observer	120
6 seamen	4,680
Rent of office	180
Rent of assistant engineer's quarters	240
Mileage and traveling expenses	200
Fuel for launch and office	350
Repairs to launch and boats	3,500
Supplies for launch and office	500
Contingencies, and for driving mooring piles	2,000
Total	18,670

Money statement.

July 1, 1886, amount available	$1,172.50
Amount appropriated by act approved August 5, 1886	10,000.00
	11,172.50
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	9,670.11
July 1, 1887, amount available	1,502.39
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	18,670.00

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., July 1, 1887.

SIR: I have the honor to report upon the improvement of South Pass of the Mississippi River, for the fiscal year ending June 30, 1887.

This work was carried on under the direction of Mr. James B. Eads until the time of his death, which occurred March 8, 1887, since which date it has been prosecuted by Messrs. James F. How and Estill McHenry, of Saint Louis, Mo., legal representatives of the deceased.

The following charts accompany this report:

No. 1.—Chart of channel from South Pass light-house, through the jetties, to deep water in the Gulf.
No. 2.—Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.
No. 3.—Chart of South Pass, from South Pass light-house to Bayou Grande.
No. 4.—Chart of South Pass, from Bayou Grande to Head of Passes.
No. 5.—Chart of the Head of the Passes.
No. 6.—Plan and comparative profiles of South Pass.
No. 7.—Sections and profiles at the Head of the Passes.
No. 8.—Diagrams showing the changes in the Gulf for each year from 1877 to 1887.

AT THE HEAD OF THE PASSES.

Since July, 1879, there has been no necessity for works of construction at the Head of the Passes, and nothing has been done there.

From an inspection of Chart No. 5, it will be seen that most of the structures there have been rendered permanent by becoming buried by deposits which they have caused to accumulate from year to year. The west T-head, east T-head extension, and upper dam are all submerged; the former remains in good condition, its upper surface being from 2 to 5 feet below the surface of the water at average flood tide. The latter constructions contained foundation mattresses laid horizontally, through which piles were driven which confined between them mattresses placed on edge, and resting upon those forming the foundation. (See Annual Report, 1879, pages 15 and 16, and Chart 7). The piling is gradually disappearing, and, of course, what remains of the upright mattresses must, in consequence be carried away, and in places where a considerable scouring has taken place near these works I am unable to detect the foundation mattresses; they have either settled, in consequence of the scouring, and become buried by sediment, or have been swept out of place.

On Chart No. 5 the portions of these works where the piling is still in place is represented by a heavy line. Of the remaining portions of the east T-head extension, I consider that 450 feet in length of the original 900 feet, measured from the junction of upper dam and east T-head extension, has entirely disappeared.

Following to the eastward on the line of upper dam, the first break through which there is a depth of 14 feet was caused by a steamer being run on top of the work there April 9, 1887. Through the next break there is a depth of 22 feet, while farther to the eastward the depths vary, and at intervals the foundation-mattresses can not be detected. As originally constructed this dam was 1,675 feet in length above water, with a foundation 1,880 feet long. The foundation-mattresses are still in place, except for a length of 350 feet, which comprises 240 feet of the extreme easterly end, the remainder being shorter portions, at intervals, farther to the westward.

It seems evident from an inspection of Chart No. 5 that with the deterioration of this dam the shoal area below it will be washed away and much of the material carried into South Pass. This, however, is not, at the present time, specially important, since the depth in South Pass below this point is so great, that a considerable shoaling would not be detrimental to the channel.

Mattress-sill across Southwest Pass.—Commencing at a point 100 feet from the east end of this sill, there are 400 feet of it which seems to have disappeared entirely; for the next 900 feet there has been an average settlement of 4 feet during the year, while over the remaining length there has been a deposit of 1½ feet.

Since March, 1879, the portion of this sill which has not washed away has settled 11 feet for the first 1,000 feet from the east end and 3.5 feet for the remainder. As will be seen on Chart No. 5, the water is very deep below where the mattresses have been washed out, and in consequence of this deepening, which is caused by strong eddies and whirls during high river, the sill has probably been undermined.

Mattress-sill across Northeast Pass.—This sill is still in place and in good condition. During the year the depth of water over it has decreased about 1 foot, in consequence of a deposit on the sill. Since October, 1877, it has settled quite uniformly about 3 feet.

IN SOUTH PASS.

Above Goat Island.—During the month of April Dam No. 2, above Goat Island, was extended 74 feet, and a shore protection of 44 feet built, the latter being simply the overlapping of willows on to the shore to prevent the flow of water around the shore-end of the dam.

This dam consists of three rows of piles 8 feet apart, the piles in each row being 9 feet apart, and those in the upper row are connected by 12 by 12 inch timber. The space between the piles was then filled with willows, which were heavily ballasted with stone.

In the construction of this dam 40 piles, 264 cords of willows, 115 cubic yards of stone, and 113 linear feet of 12 by 12 inch timber was used.

In the same reach another wing-dam, No. 9, was built, projecting from the west shore 1,420 feet above, and of the same construction as No. 2. It is 64 feet long, and contains 30 piles, 156 cords of willows, 65 cubic yards of stone, and 114 linear feet of 12 by 12 inch timber.

These dams are shown on Chart No. 4. Other and similar structures in this reach, previously reported, and mostly of a temporary character, having induced the building out of the east bank of the pass, are mostly buried by deposits, and are no longer of importance.

Near Grand Bayou.—During the month of December Wing-dams 3, 4, 5, 7, 8, and 9, near Grand Bayou, were made more serviceable by the further addition of materials to bring them above the surface of the water. Numbers 3, 5, and 7 were strengthened by additional piling, and to these and the others were added willows and stone.

These dams are shown on Chart No. 4, and the following materials were used in rebuilding them: 25 piles, 642 cords of willows, and 350 cubic yards of stone. They are now in fair condition, and the dams across Grand and Picayune bayous are permanent, and have effected the complete closure of these outlets.

AT THE MOUTH OF SOUTH PASS.

Main jetties.—Relative to the condition of the main jetties, we have only to consider that portion of the east one below a point 4,841 feet from East Point, where it commences. The portion above this point, and the whole of the west jetty, are now practicably and permanently secured by sediment deposited about and upon them.

The concrete work on the east jetty was still further demolished by the storm of October 11, which was similar to, though of greater force than, that of September 9, 1882.

On the previous day advices from the Chief Signal Officer gave warning of the approaching storm, and barometers indicated unusual weather. The wind was then from east-northeast and gradually increasing. Early on the morning of the 11th the tide began to come in rapidly, and the surface of the water in Garden Island Bay was raised by the wind as well, and by noon the highest point of land was flooded, walks were carried away, and the rapidly rising waters soon began to flood our homes. Danger seemed imminent and retreat necessary, so that residences were vacated and the inhabitants sought the safest retreat here—the hotel—which was reached with difficulty, for a battle with the elements was a trial which had to be endured.

At 2 p. m. our anemometer became disabled, so that the greatest force of the wind was not recorded. Its force, however, was not less than in 1882, when at times it registered over 100 miles per hour. Fortunately it maintained a northeasterly direction till it began to decrease, about 7 p. m., when it changed to east-southeast, and later to southeast, and by 9 p. m. the indications were that the storm was subsiding.

The damage done to the east jetty consisted in the breaking up of and moving from the foundation-blocks 689 feet in length of parapet-wall near the sea end of the jetty, so that at present but 1,563 feet in length of the original 5,432 feet remains substantially as built. The portions in place are in three sections, two near the sea end, and one below a point 6,400 feet from East Point.

For 1,160 feet in length the foundation-blocks are in place, without the parapet-wall, which was built upon them; for 2,512 feet in length the parapet-wall and foundation-blocks are moved from their original position and badly broken up, and for 197 feet in length the foundation and parapet have disappeared entirely.

The above explains the condition of the east jetty for a length of 5,432 feet from the sea end. Above this point there is 1,500 feet in length, consisting of mattresses heavily weighted with stone, as originally built, and is in good condition, its upper surface being about the level of average flood-tide. The remaining 4,841 feet of this jetty is securely buried by sediment.

Most of the masonry on this jetty is above the surface of the water at high tide, and, even in its badly demolished condition, serves to break the face of the sea, which, after traversing the shoal area between it and the inner jetty, has but little force to expend on the latter, and thus the channel is secure against deterioration.

So much of the concrete work on this jetty having been destroyed, the question of its settlement is no longer of interest or importance. The same is true in regard to the concrete blocks on the west jetty, since the land formation near them must influence their subsidence. The settlement due to the weight of the concrete itself is of most interest and value, and this result will be found in previous reports.

Inner east jetty.—From time to time during the year materials have been added to this jetty at places where it would settle down to or below the surface of the water, and at some more exposed points its width has been increased by extending the willows on to the shoal area between it and the main jetty, and forming a slope towards that jetty; large quantities of stone are placed on this slope, and the jetty throughout appears quite substantial. Its upper surface is from 2 to 4 feet above average flood-tide. It is shown on Chart No. 1; and the following materials were added to it during the year: 4,766 cords of willows and 3,252 cubic yards of stone.

Inner west jetty.—This jetty has been extended up-stream 480 feet from ΔC, and the rows of piles which were being driven near the sea end at the end of the last fiscal year have been completed, and the whole work consolidated and brought above the surface of the water. It is shown on Chart No. 1, each line representing a row of piles, between which willows and stone are placed. This work is substantial and in good condition, being uniformly about 4 feet above average flood-tide.

The following materials were used in its construction during the year: 279 piles, 5,630 cords of willows, and 3,267 cubic yards of stone.

Wing-dams.—During the year three wing-dams were built, projecting from the west jetty. They are the same in construction, consisting of two rows of piles 8 feet apart each way, and a shorter third row at the river end to make them wider there and render them less liable to be undermined by the scouring which usually takes place around the ends of such dams. In two of these dams the piles in the upper row and those in the shorter lower row are connected by 12 by 12 inch timber bolted to them. Between the piles willows weighted with stone are placed.

These dams are numbered 30, 31, and 32 on Chart No. 1. No. 30 connects the inner west jetty with the main jetty, is 147 feet long, and contains 24 piles, 182 cords of willows, and 80 cubic yards of stone.

No. 31 is 135 feet in length, and contains 44 piles, 146 cords of willows, 75 cubic yards of stone, and 234 linear feet of 12 by 12 inch timber.

No. 32 is 127 feet long, and contains 27 piles, 233 cords of willows, 50 cubic yards of stone, and 106 linear feet of 12 by 12 inch timber.

DREDGING.

No dredging has been done at any locality since February 22, 1883.

THE PLANT.

During the year one willow barge 80 by 18.4 feet and a floating derrick were built. Repairs were made to the dredge-boat, one steel barge, and one flat-boat, and 8 mooring piles driven along the pass.

MISCELLANEOUS WORK.

At times when the force could not be employed to advantage on the jetties, the work of discharging and distributing ballast, repairing dwellings, walks, etc., was done.

FORCE EMPLOYED.

The average force employed up to June 1, including officers, mechanics, and laborers, was thirty-four in number. On June 1 the force was temporarily reduced to sixteen in number.

EXAMINATIONS AND SURVEYS.

The results of examinations and surveys made during the year to determine the condition of and the changes in the channel were reported monthly, and they, together with similar results obtained during previous years, since 1875, are given in this report both in tabular form and by graphical representations, and furnish information in detail concerning the present condition of the channel, and the changes which have taken place in it, from the main river throughout South Pass, through the jetties at its mouth, and beyond the jetties 1¼ miles to a depth of 100 feet of water in the Gulf of Mexico.

The results of tidal, sediment, and velocity observations for a period of years were given in your last annual report, and as those obtained during the year add nothing of interest or importance, they are omitted in this report.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5, and on Chart No. 7 are given comparative profiles and sections, which explain the changes which have taken place there during the year and since 1875.

The improvement in depth into South Pass seems to be the most permanent feature which maintains from year to year in this locality.

The area subject to the greatest changes is wholly above the works of construction, and the changes are dependent upon the condition of the latter, principally the upper dam combined with the effect of the fluctuations in the stage of the river. While the upper dam remained intact, or while the foundation mattresses remained undisturbed, though at times there was a wide range of fluctuations, yet there was a progressive and marked shoaling above this dam. This has all been erased during the past year, and but little of the area above this dam is shoaler than it was in 1875.

While the condition of this dam continues to change, so also will the depth over this area, influenced by the stage of the river, continue to change, and, while the results are interesting, they are not of value, under the circumstances, in aiding a prediction as to the future of this area.

Using sections GH and IJ, Chart No. 7, the reduction of the shoal above Upper Dam will be readily understood. According to these sections there has been a uniform shoaling of 2 feet during the year, from either bank of the river towards the center for a distance of from 1,300 to 2,000 feet, and a shoaling also since 1875. The remainder of section IJ shows a decided deepening during the year, and since 1875. That portion of section GH 1,800 feet eastward of the center of that section shows a deepening of 3 to 6 feet during the year, and a deepening since 1875.

Profiles A B indicate but little change in depth during the year, or since 1875, above a point 1,000 feet above Upper Dam; following downward from a point 500 feet above that dam the depth has been greatly increased during the year for a distance of 2,200 feet, and farther down the channel has shoaled in some places and deepened in others. The great deepening which has taken place in the entrance to South Pass since 1875 will be seen from these profiles.

Profiles C D show a slight deepening in Southwest Pass during the year above a point 1,100 feet above the mattress sill, and below that point the deepening increases, being greatest below the sill. Since 1875 there has been a quite uniform deepening of about 3 feet.

Profiles E F do not show the greatest change in Northeast Pass, for, as was seen from sections GH and IJ, there has been a decided deepening west of the line EF. However, we may make comparisons by these profiles.

Above a point 500 feet above the mattress sill there has been a shoaling of from 1.5 to 3 feet during the year; from this point down to the sill there was no change, and below the sill a shoaling of from 1 to 4 feet.

Above a point 1,000 feet above the sill there has been but little change since 1875, but below that point there has been a deepening varying from 1 to 9 feet, being greatest below the sill.

This is the first year since 1884 that there has been a 30-foot channel from the main river into Northeast Pass. As a general result there has been a deepening at the head of the passes during the year, and since 1875.

Throughout the year, except during the month of June, the available depth from the main river into South Pass has been 30 feet or more, but the river having fallen rapidly, caused a shoaling which decreased the depth of this channel. At present the available depth is 29 feet, and at all times throughout the year the 26-foot channel has been very wide.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

During the month of November I made a complete survey of South Pass, the charts of which are Nos. 3 and 4. As compared with a similar survey made during the same month in 1886 there has been a shoaling above Grande Bayou during the year, varying from 1 to 2¼ feet in vertical height, and below the bayou a shoaling of 1 foot down to a point 1¾ miles above South Pass light-house, below which the pass has deepened from 1 to 3 feet.

As compared with the survey of 1875 there has been a decided shoaling throughout the pass, except in the reach 1 mile in length above South Pass light-house, which has deepened from 1 to 5 feet. The greatest shoaling is above Grande Bayou, and varies in vertical height from 4 to 12 feet, while below the bayou it varies from 3 to 7 feet.

As a general rule the greatest shoaling has been in the deeper reaches of the pass, and thereby the tendency is towards uniformity of depth throughout the pass.

I invite special attention to the information given on Chart No. 6. The results thereon constitute a complete record of the changes which have taken place in the channel, from the main river throughout South Pass, and through the jetties at its mouth, since 1875.

The minimum depths in the pass usually obtain during low river, and the maximum depths during high river. This survey, which is always made during low river, develops the least depth and width of channel throughout the pass during the year, except occasionally, when some temporary and abnormal shoaling takes place in the wider reaches during high river.

During the month of March a shoaling took place in the reach above Goat Island, at a point 1⅝ miles below head of passes light-house, caused by a scouring which was going on at the head of the passes, in consequence of which the water became overcharged with sediment to that extent that the power of the current was not sufficient to keep it in suspension, and a quantity of it was deposited at this locality, till the scouring at the head of the passes had ceased, when it was again moved by the current and the channel cleared.

Repeated surveys developed the very interesting phenomenon of the movement of this material, in separate and distinct masses, along the bottom of the pass, throughout a reach 2,000 feet in length. These lumps or masses of sand were constantly in motion and moved in nearly a straight line, at a quite uniform rate of 80 feet per day, and while moving would gradually wear away, and others would follow in succession. Thus, the channel through this reach was constantly changing from March 17 to April 27, on which latter date I found that the channel had resumed its normal condition.

During this period a navigable depth of 26 feet was maintained, except for three days, March 23, 24, and 25, on which days the navigable depths were 25.1, 25.2, and 25 feet, respectively.

The present available depth in this reach is 29 feet, and the 26-foot channel is 380 feet wide.

The least depth obtained during the year in Grand Bayou Reach was 27 feet, and the greatest 30.3 feet. The present depth is 28 feet, and the 26-foot channel is 200 feet wide.

At other localities throughout the pass the depth and width of the channel is substantially as shown on charts 3 and 4, and as are contained in the following table:

Tabulated statement of the depth and width of channel throughout South Pass of the Mississippi River, from East Point to 30-foot depth in the main river, given in separate reaches one-fourth of a mile in length, from a survey made in November, 1886.

Locality.		Least available depth.	Least width for—	
From—	To—		26-foot depth.	30-foot depth.
East Point	¼ mile above East Point	33.8	37.0	16.0
¼ mile above East Point	½ mile above East Point	32.3	43.0	24.0
½ mile above East Point	¾ mile above East Point	34.1	41.0	26.0
¾ mile above East Point	1 mile above East Point	36.9	34.0	20.0
First mile		32.3	34.0	16.0
1 mile above East Point	1¼ miles above East Piont	33.5	39.0	22.0
1¼ miles above East Point	1½ miles above East Point	32.6	44.0	24.0
1½ miles above East Point	1¾ miles above East Point	31.0	44.0	24.0
1¾ miles above East Point	2 miles above East Point	31.7	49.0	25.0
Second mile		31.0	39.0	22.0
2 miles above East Point	2¼ miles above East Point	32.9	46.0	36.0
2¼ miles above East Point	2½ miles above East Point	33.9	44.0	39.0
2½ miles above East Point	2¾ miles above East Point	34.9	42.0	39.0
2¾ miles above East Point	3 miles above East Point	34.8	42.0	38.0
Third mile		32.9	42.0	36.0
3 miles above East Point	3¼ miles above East Point	31.7	45.0	39.0
3¼ miles above East Point	3½ miles above East Point	31.6	42.0	20.0
3½ miles above East Point	3¾ miles above East Point	30.5	44.0	18.0
3¾ miles above East Point	4 miles above East Point	32.5	45.0	31.0
Fourth mile		30.5	42.0	18.0
4 miles above East Point	4¼ miles above East Point	34.7	44.0	33.0
4¼ miles above East Point	4½ miles above East Point	34.6	46.0	39.0
4½ miles above East Point	4¾ miles above East Point	36.7	45.0	30.0
4¾ miles above East Point	5 miles above East Point	40.4	32.0	21.0
Fifth mile		34.6	32.0	21.0
5 miles above East Point	5¼ miles above East Point	30.7	35.0	12.0
5¼ miles above East Point	5½ miles above East Point	29.7	40.0	(1)
5½ miles above East Point	5¾ miles above East Point	28.4	39.0	(2)
5¾ miles above East Point	6 miles above East Point	27.4	30.0	(3)
Sixth mile		27.4	30.0	....
6 miles above East Point	6¼ miles above East Point	27.5	30.0	(4)
6¼ miles above East Point	6½ miles above East Point	27.5	43.0	(5)
6½ miles above East Point	6¾ miles above East Point	32.5	40.0	23.0
6¾ miles above East Point	7 miles above East Point	31.5	40.0	27.0
Seventh mile		27.5	30.0	....
7 miles above East Point	7¼ miles above East Point	34.2	47.0	27.0
7¼ miles above East Point	7½ miles above East Point	33.0	42.0	29.0
7½ miles above East Point	7¾ miles above East Point	37.1	38.0	32.0
7¾ miles above East Point	8 miles above East Point	41.1	39.0	29.0
Eighth mile		33.0	38.0	27.0
8 miles above East Point	8¼ miles above East Point	37.1	39.0	30.0
8¼ miles above East Point	8½ miles above East Point	33.8	44.0	28.0
8½ miles above East Point	8¾ miles above East Point	33.1	28.0	19.0
8¾ miles above East Point	9 miles above East Point	35.0	26.0	17.0
Ninth mile		33.1	20.0	17.0
9 miles above East Point	9¼ miles above East Point	33.7	27.0	17.0
9¼ miles above East Point	9½ miles above East Point	29.7	40.0	(6)

	Feet.
[1] Length of the portion of this reach lacking a central depth of 30 feet	480
[2] Length of the portion of this reach lacking a central depth of 30 feet	870
[3] Length of the portion of this reach lacking a central depth of 30 feet	1,140
[4] Length of the portion of this reach lacking a central depth of 30 feet	1,320
[5] Length of the portion of this reach lacking a central depth of 30 feet	670
[6] Length of the portion of this reach lacking a central depth of 30 feet	630
Total length of channel (in 12 miles) lacking a central depth of 30 feet	5,110

Statement of the depth and width of channel throughout South Pass, etc.—Continued.

Locality. From—	Locality. To—	Least available depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.
9½ miles above East Point	9¾ miles above East Point	30.7	39.0	29.0
9¾ miles above East Point	10 miles above East Point	51.0	39.0	32.0
Tenth mile		29.7	27.0	....
10 miles above East Point	10¼ miles above East Point	39.0	33.0	26.0
10¼ miles above East Point	10½ miles above East Point	37.6	34.0	20.0
10½ miles above East Point	10¾ miles above East Point	46.6	34.0	27.0
10¾ miles above East Point	11 miles above East Point	35.3	41.0	34.0
Eleventh mile		35.3	33.0	26.0
11 miles above East Point	11¼ miles above East Point	48.2	(*)	70.0
11¼ miles above East Point	11½ miles above East Point	30.5	(*)	26.0
11½ miles above East Point	11¾ miles above East Point	31.5	(*)	(*)
11¾ miles above East Point	12 miles above East Point	30. +	(†)	(†)
Twelfth mile		30. +	(*)	26.0

* Very wide. † In Mississippi River above head of passes.

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties is shown on Chart No. 1. The fluctuations throughout it during the year were unimportant and comparatively slight, and at all times a much greater depth and width than required was maintained.

The following table gives the least depth and width of channel through the jetties, and serves to explain the changes in the depth and width of that channel from month to month during the year.

Tabulated statements regarding the minimum depths and widths of channel through the jetties, in separate reaches of 2,000 *feet each, according to surveys made monthly during the fiscal year ending June* 30, 1887.

[Distances from East Point, in feet.]

Date.	0–2,000. Least depth.	0–2,000. Least width for 26-foot depth.	0–2,000. Least width for 30-foot depth.	2,000–4,000. Least depth.	2,000–4,000. Least width for 26-foot depth.	2,000–4,000. Least width for 30-foot depth.	4,000–6,000. Least depth.	4,000–6,000. Least width for 26-foot depth.	4,000–6,000. Least width for 30-foot depth.	6,000–8,000. Least depth.	6,000–8,000. Least width for 26-foot depth.	6,000–8,000. Least width for 30-foot depth.	8,000–10,000. Least depth.	8,000–10,000. Least width for 26-foot depth.	8,000–10,000. Least width for 30-foot depth.	10,000–12,000. Least depth.	10,000–12,000. Least width for 26-foot depth.	10,000–12,000. Least width for 30-foot depth.
1886.																		
June	38.2	350	200	35.2	370	300	33.4	380	280	33.2	240	170	34.5	320	240	36.5	330	240
July	36.7	340	190	36.7	300	300	36.2	370	290	32.8	270	190	32.7	270	200	37	270	190
August	35	370	210	36.3	320	290	35.7	380	300	34.8	270	190	33.8	270	200	34.7	290	210
September	34.5	350	190	35.6	350	300	34.6	370	300	33.7	290	200	33.6	290	190	33	270	190
October	35	340	200	36.2	350	290	34.4	350	260	33	240	180	34.1	270	200	33	260	200
November	34.5	310	210	35.6	350	280	34.8	350	270	32.9	280	200	33	200	190	33.5	270	200
December	34	330	190	35	340	280	35.3	360	200	33.6	260	190	32.6	300	200	33	280	200
1887.																		
January	33.6	320	200	34	330	270	33.3	360	260	32.3	240	170	32.7	240	170	33.4	280	190
February	36.4	330	200	34.4	340	300	33.4	350	270	31.3	300	190	34.1	270	140	32.4	280	140
March	35.5	360	220	35.5	360	310	32.6	350	[illegible]	35.5	310	240	35.5	260	190	33.8	280	190
April	38.8	350	230	37	360	300	33.7	370	290	31	310	140	34.8	320	250	35.5	310	240
May	39.4	330	180	35.3	370	320	37.1	390	320	31.2	290	210	34.2	290	210	38.1	300	230
June	39	350	190	35.4	330	280	37.5	380	330	32.8	280	210	34.1	250	180	35.2	270	190

According to the above, the least depth through the jetties at present is 32.3 feet; the least width of the 26-foot channel is 250 feet, and of the 30-foot channel 130 feet. The profile on Chart No. 6 gives more detailed information regarding the depth of this channel, and compares the present depth with that in 1875, before the jetties were built.

Beyond the ends of the jetties, and on a direct course from there into deep water in the Gulf, there is a central depth of 30 feet, the 26-foot channel being 210 feet wide and the 30-foot channel 60 feet wide. The channel turning to the eastward at a point 600 feet beyond the end of the east jetty, though less practicable, has a greater depth and width. In this channel the central depth is 30.2 feet, and the 26 and 30 feet channels are, respectively, 260 and 170 feet wide.

The straight or direct channel beyond the ends of the jetties has maintained since October, 1886, previous to which date, and from June, 1884, it had shoaled so that it contained less than the required depth and width.

The following table gives the minimum depths through the jetties at various dates since the commencement of the works of improvement, and serves to show the progressive channel improvement from that time to the present.

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875.						
June	22.5	18.7	16.7	10.2	9.7	9.2
1876.						
May	23.3	20.3	22.0	21.0	17.1	15.0
August	23.5	19.6	21.0	23.5	23.0	19.8
November	22.0	20.3	21.1	21.2	21.1	20.3
1877.						
March	24.1	21.1	23.2	22.0	21.2	20.5
July	24.9	24.0	26.0	23.6	23.5	20.3
Oct. 25 to Dec. 14	26.3	24.4	28.5	24.2	23.0	23.7
1878.						
March	26.0	25.9	35.5	25.4	24.3	23.0
December	28.4	26.4	35.7	27.1	25.3	23.0
1879.						
March	28.6	27.5	43.4	27.0	27.0	27.0
June	27.5	28.4	47.7	29.2	29.2	28.0
July 8	30.5	30.7	.....	31.0	30.7	30.5
December	31.0	31.0	48.3	31.7	31.8	30.8
1880.						
June	31.0	32.5	47.8	31.4	35.1	32.0
July	30.5	31.0	44.0	30.8	31.5	30.5
August	30.5	30.4	46.0	30.0	32.0	30.5
September	30.7	31.0	44.4	30.6	32.0	31.0
October	31.0	31.5	41.0	30.3	31.0	30.5
November	30.6	31.0	40.3	30.8	30.9	30.5
December	30.9	30.6	43.0	30.8	31.0	30.3
1881.						
January	30.5	30.4	41.9	33.8	30.7	30.3
February	30.4	30.2	41.6	32.0	31.0	30.0
March	31.5	31.2	41.3	32.0	32.0	30.5
April	30.4	30.0	43.0	33.0	33.0	30.5
May	30.2	30.5	42.7	32.6	30.5	31.2
June	30.0	30.5	43.8	32.0	31.7	31.7
July	31.0	32.0	42.5	33.5	33.0	32.0
August	30.1	32.0	37.6	32.0	31.0	30.2
October	30.2	30.3	38.3	31.4	31.2	30.3
November	30.8	31.8	39.2	30.4	30.0	30.1
December	30.2	31.8	39.4	30.8	30.2	30.0
1882.						
January	30.5	30.4	41.3	31.1	30.2	30.2
February	31.8	33.0	39.7	30.5	30.8	30.7
March	31.2	30.6	39.2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33.0
1882						
May	30.5	33.5	39.4	31.0	31.3	31.0
June	30.8	35.5	39.0	31.2	31.3	31.0
July	30.0	32.7	38.7	30.6	31.3	31.5
August	30.3	32.2	38.1	31.8	31.8	30.5
September	30.1	31.5	38.3	31.9	30.8	30.5
October	30.0	31.0	37.1	31.0	31.4	31.2
November	30.0	32.0	38.1	31.5	31.2	31.2
December	31.0	31.0	37.0	31.2	31.0	30.4
1883.						
January	31.0	31.0	35.2	30.2	30.1	30.1
February	31.2	31.2	36.0	30.5	30.0	30.1
March	32.3	33.6	45.7	31.5	30.3	30.3
April	33.7	35.0	44.0	32.2	30.0	30.0
May	33.2	36.3	46.0	32.8	30.3	32.4
June	32.5	34.2	45.0	33.4	31.0	33.0
July	33.8	34.9	44.0	32.0	31.5	31.8
August	32.1	38.2	48.0	33.4	33.4	32.2
September	33.4	34.3	46.0	32.8	32.3	30.6
October	32.7	34.1	41.5	32.0	32.0	30.5
November	31.0	33.8	43.8	34.5	31.5	31.0
December	30.5	32.6	43.0	31.6	31.0	30.2
1884.						
January	31.2	32.2	39.2	32.7	31.8	30.3
February	32.0	31.5	41.3	31.6	31.0	30.7
March	35.7	39.5	41.6	34.0	33.8	38.4
April	35.3	37.3	41.5	31.7	32.7	35.7
May	34.9	35.8	42.3	34.3	35.1	33.0
June	35.0	35.8	41.1	34.0	35.0	35.0
August	31.9	35.8	41.9	33.9	35.0	32.0
September	32.0	34.0	39.0	33.1	33.7	33.5
October	31.1	33.4	38.6	32.6	32.6	32.5
November	32.8	32.8	37.2	32.2	32.4	30.8
December	31.6	32.6	37.1	31.1	31.5	31.4
1885.						
January	36.7	36.4	36.9	33.1	34.6	32.8
February	41.7	36.3	35.7	30.5	34.1	36.2
March	35.5	36.0	36.1	31.0	31.7	35.7
April	36.0	35.5	37.0	32.0	32.6	32.0
May	36.7	35.0	35.6	31.5	33.5	31.5
June	34.7	33.7	35.7	32.8	32.8	31.3
July	36.3	33.1	36.5	33.7	33.6	31.0
August	36.5	35.6	37.6	33.0	32.0	31.0
September	35.3	33.3	35.2	32.2	30.7	31.7
October	33.8	33.7	35.8	31.3	30.4	30.4
November	32.7	32.8	35.1	30.8	30.6	30.1
December	33.0	32.2	34.2	30.9	30.5	30.6

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1886.						
January	33. 6	32. 5	33. 0	30. 2	30. 2	28. 5
February	32. 8	32. 8	34. 1	31. 3	30. 9	30. 0
March	32. 8	35. 8	34. 0	35. 0	33. 1	32. 0
April	35. 4	34. 5	34. 5	33. 7	33. 7	31. 0
May	35. 9	35. 6	34. 2	31. 0	36. 0	34. 4
June	38. 2	35. 2	33. 4	33. 2	34. 5	36. 5
July	36. 7	36. 7	36. 2	32. 8	32. 7	37. 0
August	35. 0	36. 3	35. 7	34. 8	33. 8	34. 7
September	34. 5	35. 6	34. 6	33. 7	33. 6	33. 0
October	35. 0	36. 2	34. 4	33. 0	34. 1	33. 0
1886.						
November	34. 5	35. 6	34. 8	32. 9	33. 0	33. 5
December	34. 0	35. 0	35. 3	33. 6	32. 6	33. 0
1887.						
January	33. 6	34. 0	33. 3	32. 3	32. 7	33. 4
February	36. 4	34. 4	35. 4	31. 3	34. 1	32. 4
March	35. 5	35. 5	32. 6	35. 5	35. 5	33. 8
April	38. 8	37. 0	33. 7	31. 0	34. 8	35. 5
May	39. 4	35. 3	37. 1	31. 2	34. 2	38. 1
June	39. 0	35. 4	37. 5	32. 3	34. 1	35. 2

SURVEY BEYOND THE END OF THE JETTIES.

The chart of this survey is No. 2. The area sounded contains more than 2 square miles, the outer limit being the 100-foot curve, which is about 1¼ miles from the ends of the jetties.

By reference to the diagrams on Chart No. 8 it will be seen that the 20, 30, and 40 feet curves changed but little during the year; the two former advanced 44 and 24 feet respectively, and the latter receded 24 feet; a result which indicates but little change immediately in front of the jetties and out to the 40-foot depth.

The outer curves, however, advanced; the 100-foot curve showing the greatest advance, of 350 feet, and the 50-foot curve the least, of 112 feet.

The following diagram shows the movement of each curve, and the amount of the same from 1877 to 1887, all having advanced.

Assuming that each mean ordinate in 1877 be zero, then the length of the ordinate in 1887 measures the advance of each curve.

For example, we see that from 1877 to 1887 the 20-foot curve advanced 509 feet, the 30-foot curve 551 feet, etc.

The portions of the 20, 30, and 40 foot curves move directly in front of the jetties, receded during the year, while on the eastward and westward they advanced, as did each portion of the outer curves. Therefore we know that the material deposited during the year has been in a greater depth than 40 feet immediately in front of the jetties and to the eastward and westward of lines which are the prolongations of the jetties.

I now determine the vertical height of the shoaling over an area containing 1¼ square miles, and the shoaling or scouring over each of twenty-one lesser areas into which it is subdivided, by obtaining the mean depth of each subdivision and of the whole area, and comparing them with results similarly obtained for previous years.

The results of these determinations from year to year since 1876 are as follows:

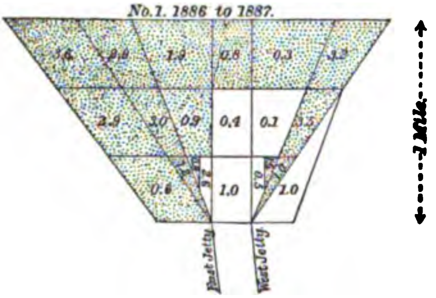
Mean change over whole area.			
From—	To—	Scour.	Fill.
1876	1877		0. 40
1877	1878	1. 80	
1878	1879		2. 56
1879	1880	0. 12	
1880	1881		2. 38
1881	1882		1. 30
1882	1883	0. 04	
1883	1884		3. 61
1884	1885	1. 16	
1885	1886		0. 12
1886	1887		1. 38
1876	1887		8. 63

By the aid of the following diagrams, which represent this area on a smal one may readily understand the distribution of the material deposited, and lo areas which are undergoing the greatest and least change.

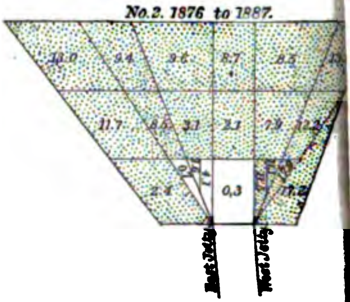
The figures in each subdivision are the differences between the mean depths divisions as obtained for the years between which the comparisons are made, press in feet and tenths of a foot the vertical height of the deepening or shoa each.

Shaded areas are those which have shoaled, and blank areas have deepened.

No. 1 results from comparing the mean depths for 1886 with those for 1887, 2 compares those for 1876 with those for 1887.



No. 1. 1886 to 1887.



No. 2. 1876 to 1887.

Again we find, what the diagrams on Chart No. 8 so clearly indicate, that the gr deposit takes place in a greater depth of water than 30 or 40 feet, and to the eas and westward of the more central areas. That the areas directly in front of th ties change so little, in comparison, is due to the fact that the strong current whi jetties produce maintains sufficient force after the water is discharged into th to prevent the deposit of material immediately in front of them.

During the last high river there was no lateral escape of water over either the inner west jetty having been completed, and it is probable that the improv in front of the jetties during the year is due to that fact.

RECAPITULATION.

From the preceding results the least depth throughout the channel from the river to the Gulf of Mexico is 28 feet, and the least width of the 26-foot channel feet.

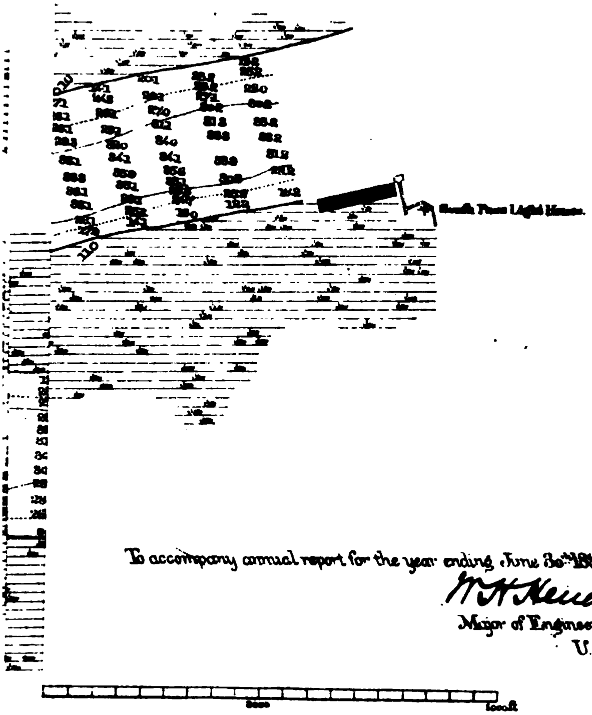
Except for three days during the year "a channel having a navigable depth feet" through the shoal at the head of South Pass and "through the pass i and "a channel through the jetties 26 feet in depth not less than 200 feet in at the bottom and having through it a central depth of 30 feet without rega width," was maintained without the aid of dredging.

In conclusion, acknowledgements are due Recorder G. W. Lawes for efficient ance during the year.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engin

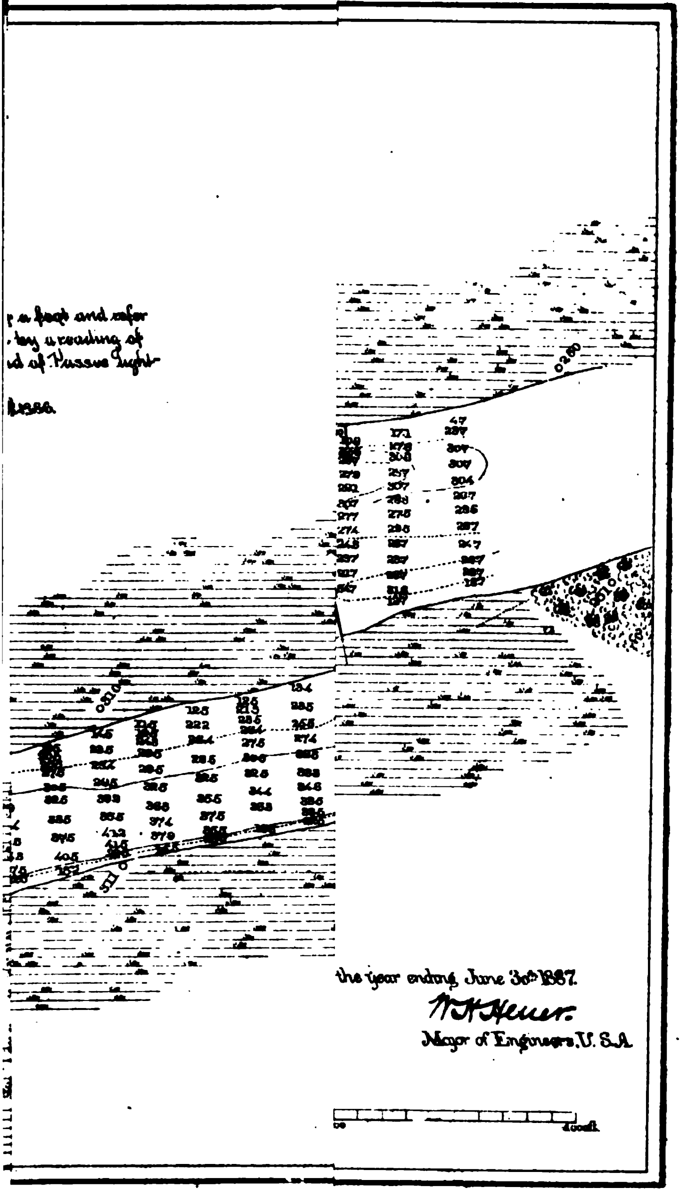
Maj. W. H. HEUER,
Corps of Engineers.



To accompany annual report for the year ending June 30th 1887.

W. H. Heuer
Major of Engineers,
U.S.A.

4

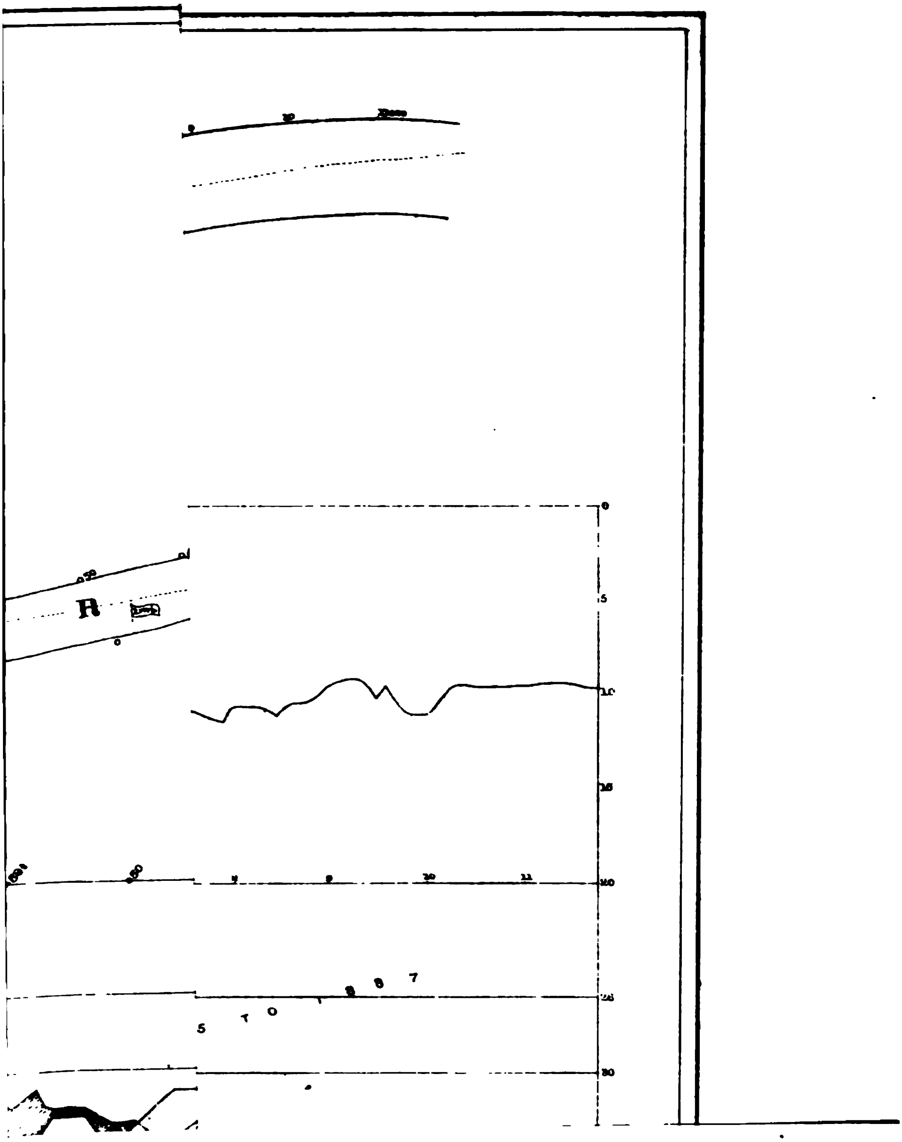


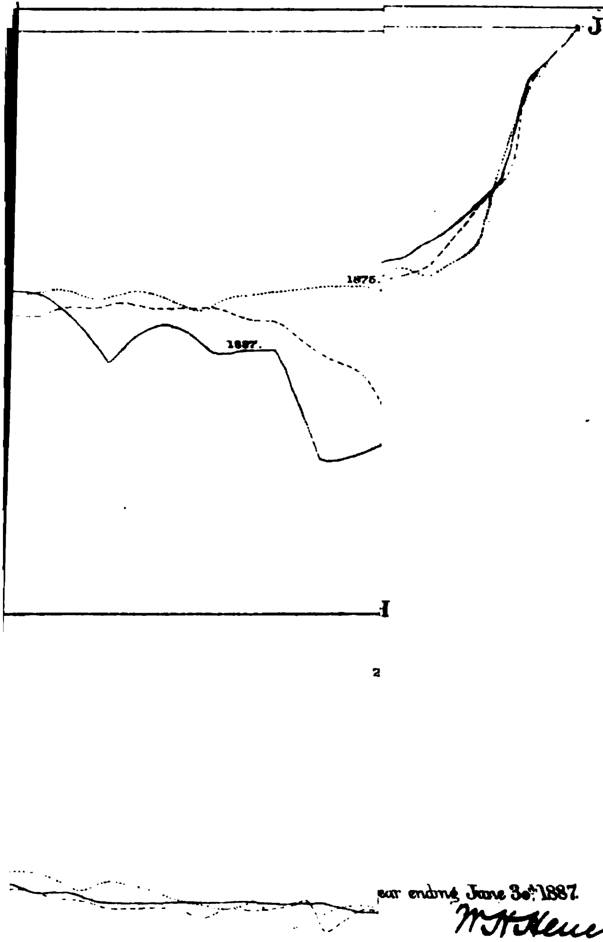
a foot and refer
by a reading of
of Tussue light

1886.

the year ending June 30th 1887.

W. H. Heuer.
Major of Engineers, U. S. A.

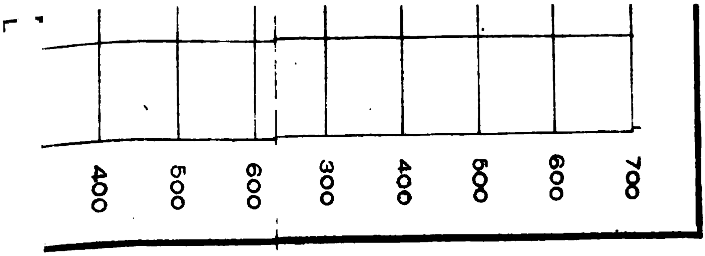

R

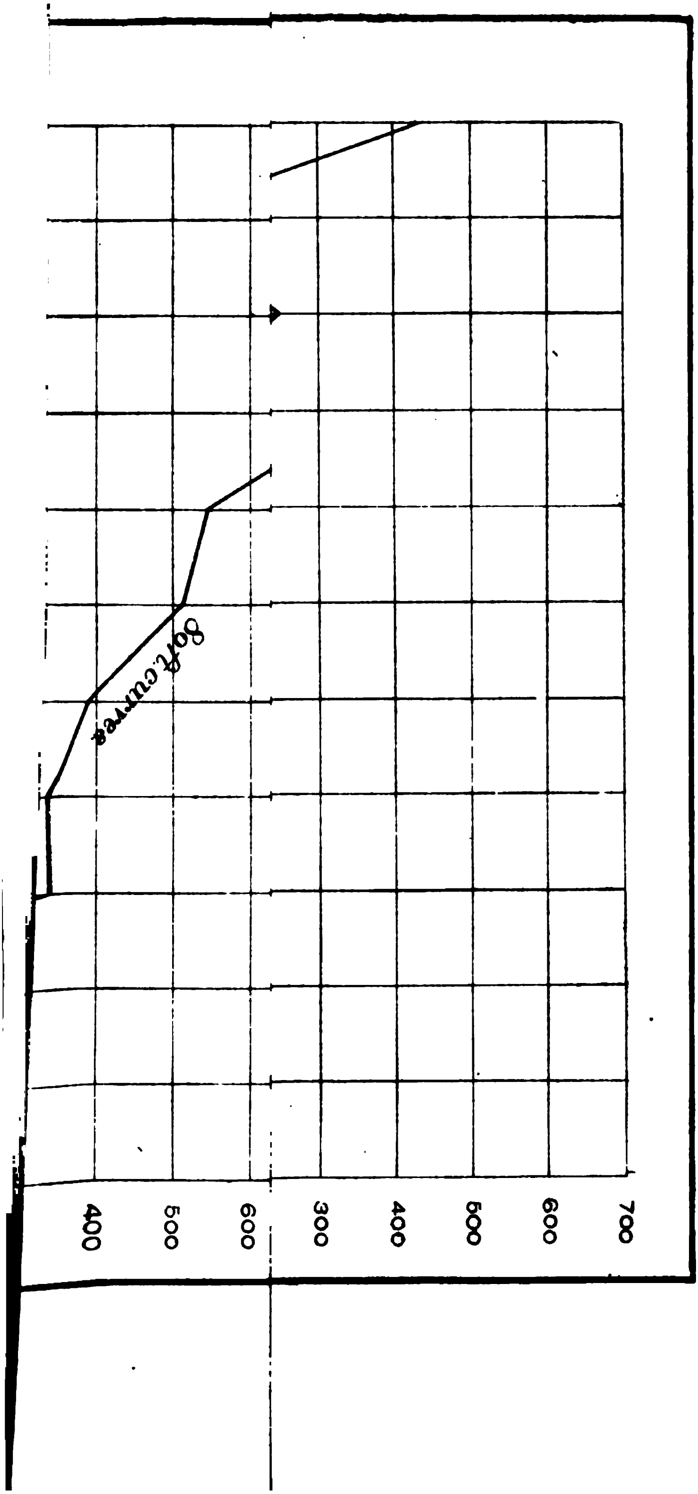


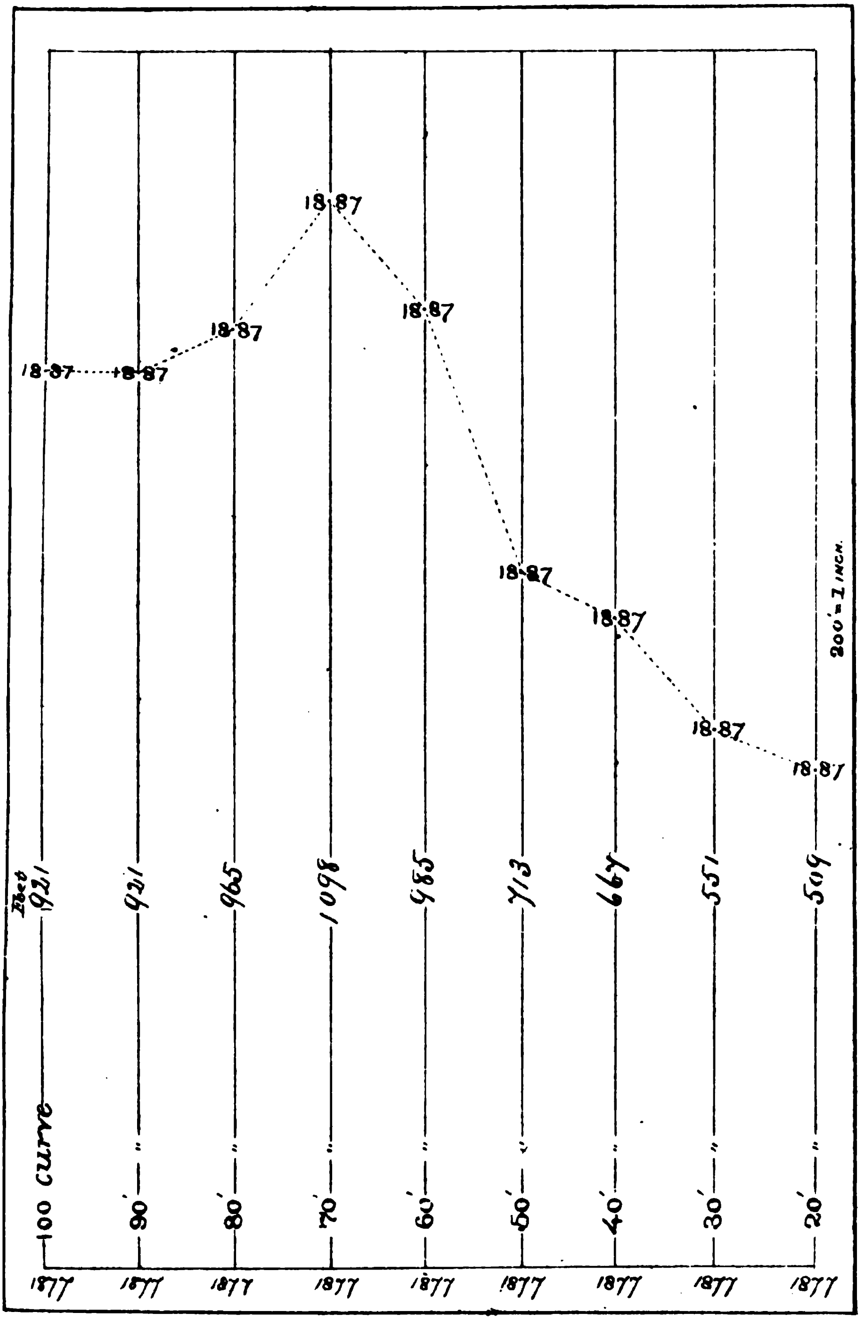
ear ending June 30th 1887.

W H Heuer

Major of Engineers, U.S.A.




Soft curves
400
500
600
300
400
500
600
700


1877
100 curve
Feet
921
18·87
1877
90' „
921
18·87
1877
80' „
965
18·87
1877
70' „
1098
18·87
1877
60' „
985
18·87
1877
50' „
713
18·87
1877
40' „
667
18·87
1877
30' „
551
18·87
1877
20' „
509
18·87
200' = 1 inch

APPENDIX S.

PROVEMENT OF THE VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA AND OF BAYOU PIERRE, MISSISSIPPI.—IMPROVEMENT OF SABINE PASS AND OF SABINE AND NECHES RIVERS, TEXAS.

PORT OF MAJOR WILLIAM H. HEUER, CORPS OF ENGINEERS, OFFICER N CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH THER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

Tchefuncte River and Bogue Falia, Louisiana.
Tangipahoa River, Louisiana.
Tickfaw River, Louisiana.
Amite River, Louisiana.
Bayou La Fourche, Louisiana.
Bayou Terrebonne, Louisiana.
Bayou Black, Louisiana.
Bayou Teche, Louisiana.
Connecting Bayou Teche with Grand Lake at Charenton, Louisiana.
10. Bayou Courtableau, Louisiana.
11. Calcasieu River and Pass, Louisiana.
12. Bayou Pierre, Mississippi.
13. Sabine River, Louisiana and Texas.
14. Neches River, Texas.
15. Sabine Pass, Texas.
16. Removal of sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEY.

Bayou Rouge, Louisiana.
Bayou Terrebonne, Louisiana, from Houma to Thibodeaux.
ayou Vermillion, Louisiana, to secure navigation from Abbeville to the railroad bridge of the Louisiana and Texas Railroad.
20. Mouth of Calcasieu River and of Calcasieu Pass, Louisiana.
21. Mouth of Bayou Plaquemine, with a view to its connection with the Mississippi River by locks; also Bayou Plaquemine and other connecting streams, to form the best route to Grand Lake, Louisiana.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 19, 1887.

NERAL: I have the honor to transmit herewith annual report for and harbor works under my charge for the fiscal year ending 30, 1887.

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

e CHIEF OF ENGINEERS, U. S. A.

S 1.

IMPROVEMENT OF TCHEFUNCTE RIVER AND BOGUE FALIA, LOUISIANA

The project for the improvement of this river was made in 1880, an contemplated the removal of overhanging trees, logs, etc., in the cha nel, and the dredging of the bar at its mouth.

The first appropriation of $1,500 was made March 3, 1881, and a sec ond one of $1,500 in August, 1882. With these two appropriations th obstructions below Covington were removed, and part of the unex pended balance was used for the construction of a working plant fo improving the bar at the mouth and part for the construction of a break water extending 820 feet into the lake.

The original estimate for improving this river was $5,460, the greate portion of which was for dredging the bar at the mouth. It was thought however, that a dredged channel over this bar could not be maintained without protecting works, which would cost considerably more than th dredging. Major Stickney, who had this work in charge, caused a re examination to be made in 1884, and in his report in the Annual Repor of the Chief of Engineers for 1884, volume 2, page 1269, he reports th river in good order, excepting the bar at its mouth, and suggests as a method for improving the bar to build a jetty or breakwater 2,500 fee long across the bar into the comparatively deep water of the Lak Pontchartrain, and then to dredge the channel through the bar, in th hope that the jetty would prevent, or, at all events, greatly retard, th refilling of the cut with sand. The estimated cost of this improve ment is $20,400, and if authorized by Congress $19,000 of this amoun should be appropriated for the fiscal year ending June 30, 1889, an applied to extending the breakwater, dredging the bar, and removin any other obstructions that may have formed since the river was cleare out. Should the improvement be made as contemplated, the protectio of the mouth of the river would also enable vessels navigating the lak to use this mouth as a harbor of refuge in case of gales.

The depth of water on the bar at its lowest stage (during a norther is about 4½ feet. The benefit to commerce is local. It is not know that there has been any increase to commerce in consequence of im provements thus far made. Should Congress desire to carry out th project for making the mouth of the Tchefuncte a harbor of refuge, th $19,000 will be required to do this. Otherwise no money for the fu ther improvement of this stream during the fiscal year ending June 3 1889, is required.

Commerce for preceding year is reported as consisting of 1,895 b cotton, 188,000 barrels sand, 3,500,000 brick, 105,000 barrels charc and 11,000,000 feet lumber.

The work is located in the collection district of New Orleans. The ne house is at the mouth of the river.

I append First Lieut. O. T. Crosby's report, sh adopted for the expenditure of the last appro therefor, together with a copy of my letter t

Mone ate

Amount appropriated by act appro
July 1, 1887, amount expended dur
outstanding July 1, 1886.....

July 1, 1887, amount av

LETTER OF MAJOR W. H. HEUER, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEERS,
New Orleans, La., October 6, 1886.

GENERAL: In accordance with circular letter from office of Chief of Engineers, United States Army, dated August 12, 1886, requiring me to submit a project for the expenditure of $2,500, appropriated by act of August 5, 1886, for improving Tchefuncte River and Bogue Falia, Louisiana, I have the honor to submit the following:

As the only survey available of the stretch of river between Old Landing and Covington, where the improvement was to be made, was fifteen years old, Lieutenant Crosby, Corps of Engineers, was directed to make a survey of this stretch. A tracing of this and a copy of his report are herewith.

The report shows that with the money available either of two projects for improving navigation might be adopted, viz, cutting through a bend, that is, making a cut-off, or dredging on each of several bars in this stretch a channel 50 feet wide.

Of the two projects referred to, that of dredging the bars would probably be of greater advantage to navigation than that of making the cut-off, for reasons clearly expressed in Lieutenant Crosby's report.

In this connection attention is invited to the report of Major Stickney on the Bogue Falia, printed in Annual Report Chief of Engineers, 1884, Part 2, page 1283.

I would therefore recommend that a channel 50 feet wide be dredged through each of the bars between Old Landing and Covington, commencing on the first bar above Old Landing and continuing the work towards Covington as far as the funds permit; that the work be done by contract, after due advertisement.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, *La., September* 6, 1886.

SIR: I have the honor to report as follows upon a survey of Bogue Falia River, Louisiana, made by your orders of recent date. The survey covered a stretch a little more than 3 miles in length, extending from a low bridge, at the upper end of the town of Covington, down to Old Landing, the upper limit of navigation for the larger steam-boats now running in the Tchefuncta or Bogue Falia trade. The object of the survey was to obtain data for determining the most beneficial method of expending the recent appropriation of $2,500. Navigation up to Old Landing is good, large steamboats reaching that point whenever business offers. Two classes of obstructions prevent such steamboats from going on to Covington, sharp bends and shoal bars. There is no trade at Old Landing itself; all passengers and freight landed there being transported over a 2-mile distant road to Covington. Corresponding to the two difficulties mentioned above, two plans of improvements have been suggested for the stretch under consideration, namely, the making of cuts across the sharper bends, and the removal of bars by dredging. The bends do not prevent a number of schooners from reaching Covington, nor do they even seriously inconvenience them, while the bars often cause delay. Because the schooners are able to reach Covington they now carry almost all the freight, the steamboats doing a passenger and express business, which in the winter amounts to very little.

Could a steamboat reach the Covington Landing it would probably take much of the freight, and the people seem desirous of having steam rather than sail service. To cut across the first bend above Old Landing, and this is about the worst of the four or five bad bends, would permit a steam-boat drawing 5 feet to reach a point known as Grant's Landing, about 1 mile from Covington. One shoal place is met before reaching Grant's, but it was regularly passed during the whole of last year by the *Grover Cleveland*, a propeller drawing about 5 feet. This boat being rather short was able to make the bends without much difficulty. She has now been withdrawn from this trade, leaving the *Camelia*, a side-wheel boat, 170 feet long, drawing about 5 feet, and the *Day Dream*, about 120 feet long, and drawing about 6.5 feet. This boat I saw making the bend nearest Old Landing; it was a matter of great difficulty and in a lower stage of water, allowing less swing, would be all the harder. In the hope that one of these two boats or some other will make regular trips as far as Grant's Landing, the citizens of Covington seen by me favor the expenditure of the money now available in making a cut across the bend referred to above.

Judge Thompson, presiding over the State judicial district in which Covington lies, informed me that the saving of something over a mile of wagon transportation, to be thus effected, would be of much value both as to passengers and freight. The owner of the *Pippo*, the principal schooner running in the trade, urges that the appropriation be expended in dredging the bars, thus facilitating the passage of schooners, which to-day do the bulk of the business, much troubled as they are by the bars. He thinks that unless steamboats can go quite to the wharf at Covington an extension of their trips to Grant's would be of little benefit. The proposed cut would have sides 150 feet long, would go through land about 15.5 feet above low water, and if cut to 6 feet below that plane, and 100 feet wide, would require the excavation of about 12,000 cubic yards of sandy clay. It could be done for the amount available, or if unforeseen expenses occurred, this amount would complete it to less though still navigable width. Except during freshets, occurring irregularly and lasting from two to five days, the Bogue Falia is a tidal stream bearing no sediment. The cut would therefore hold, even without damming the principal stream in any way. During freshets the current is very strong, there being a fall of 20 feet or more in 14 miles. The distance from end to end of the cut, by the bend, is about 2,000 feet, consequently if this locality has the average slope there would be a fall of 9 inches from end to end through the cut only 150 feet long. The current produced by such a fall would doubtless enlarge an excavation made through such yielding earth. There is a depth of 20 feet for some distance below the cut, so that considerable deposit might take place without injury to navigation. The stream being tidal to a point above Covington, no injurious diminution of depth need be feared above the cut.

The property through which it would be made can be had for about $100 or less. This is the valuation put on it by Mr. Smith, resident of Covington and agent of the owner. He can not make a positive offer, because of a lease running until January 1, 1887. The lessee is a resident of this city, therefore was not seen by me, but will be interviewed as soon as found.

The only dredge-boat that I know to be anywhere near the contemplated work is one owned by parties who are employed from time to time in cleaning out the two State canals, extending from the city to Lake Pontchartrain.

In case dredging should be found very costly the work could be done dry, with the exception of natural dams left at either end, to be afterward cut down gradually in the water. The bars are composed of movable sand, easily dredged, or when there is a current running down-stream, easily washed out between constructions diminishing channel width. To apply the second method to all the shoals would be a matter of considerable expense, quite beyond the present appropriation. And, moreover, the effect would be of but little longer life than that produced by dredging. The material moved would be redeposited in a deeper place, and this, together with the general increase of deposit going on, would soon produce another bar. That there is a general shoaling may be seen by a comparison of the chart submitted with this, and one made in 1871 under direction of Major Howell. The surroundings show no increase of depth, while in many cases decrease is observable, ranging from 1 foot to 10 feet.

The fact that the digging of sand, an industry considerably developed during the past fifteen years, has loosened the banks along a considerable portion of the stream, would lead one to infer that filling must have taken place and will continue to take place. On the other hand the filling has not been so extensive, nor do the known conditions promise in future that it will be so extensive, as to render dredging a valueless operation.

As the stream is to-day, the removal of 10,000 cubic yards of material would give 5 feet up to Covington, the dredged width estimated at 50 feet. Since short steamboats can and do make the bends while they can not get over the shoals, this plan would seem to give greater relief at first than that of the cut. It also has the advantage of securing some certain benefit, while in case of the cut it might or might not be used by vessels now prevented from ascending to Covington. As it will permit certain classes of both steam and sail vessels to compete with each other at Covington, I believe it will prove of greater benefit to the people than the cut, which would benefit steam-vessels alone, and would not of itself carry these to Covington. In case another appropriation be made for this stream, and that before the deepening resulting from any work soon to be done had disappeared, the making of the cut would doubtless be a proper application of it. Even now there is no *great* difference of value between the two projects. I recommend dredging of the bars as being not *greatly* but somewhat more beneficial than the cutting. As the work will be easy, it can probably be done for 25 cents per cubic yard, distant as the locality is from any accumulation of dredging plant. Should this figure be obtained the money available would carry 5 feet up to or very nearly up to Covington Landing. The material removed may be found to have a marketable value. I was informed that six or eight trees on the shoal bottom give some trouble to passing schooners. These could be removed at trifling expense. The cost of the survey was $21. Angles were read on a Gurley transit, distances by stadium rod.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieut. of Engineers.

Maj. W. H. HEUER,
Corps of Engineers.

S 2.

IMPROVEMENT OF TANGIPAHOA RIVER, LOUISIANA.

An appropriation was made in 1872 and was expended in clearing the river of snags, rafts, and leaning trees over a distance of 16 miles from its mouth. Examination and survey were authorized June 18, 1878. The survey was begun in 1879. The assistant engineer who made the survey found many obstructions, such as snags, overhanging trees, etc., and estimated the cost of their removal up to Conner's Bridge, 1½ miles from Amite City and 53 miles above the mouth, at $10,000.

This improvement would give a clear channel 42 inches deep to a point 32 miles above the mouth and for a further distance of 21 miles a clear channel of 24 inches. An appropriation of $5,000 was made June 18, 1880. On September 22, 1880, agreement was made with Carl P. Segmet for clearing 34 miles, for the sum of $4,750. On March 3, 1881, an appropriation of $2,000 was made for continuing the improvement. The approved project for expending this sum provided for continuing the work above the point to be reached by first contract. One bid was received on this, and being considered excessive was rejected. The first contract was reported completed in November, 1881, and the work was accepted. On January 3, 1883, a contract was made with C. E. Cate for clearing out 7¼ miles, at $235 per mile; the work was accepted late in June, 1884, having been reported twice as finished and twice rejected.

On August 14, 1884, the Government plant that had been laid up at Springfield with a hired crew, proceeded in charge of a superintendent to the Tangipahoa River, under instructions to commence work where Cate's contract ended and extend the improvement, if practicable with the funds on hand, to Amite City. The stage of water was very low, and after forcing a passage through numerous obstacles, such as stumps, sunken logs, overhanging trees, land-slides, shoals, and two wooden bridges, to within about 4 miles of the point at which it was intended to begin work, it was found impracticable to proceed any further, and under a modification of instructions the plant was dropped down to Lanier's Bridge, and the work of clearing out the stream from there down to the mouth commenced September 15 and was completed October 11, 1884. About 12 miles of the 53½ miles included in the project for the improvement of Tangipahoa River have not been touched. Major Stickney's last report recommends an appropriation of $1,700 to be made for completion, to be applied, however, in recleaning the lower river, which is again obstructed. He also suggests that it might be well to consider now some plan for removing the bar at the mouth, which permits only light-draught vessels to enter. The work for the lower river has been completed, an appropriation of $2,000 having been made July 5, 1884. It is believed that it will be useless to carry the improvement any further up-stream, and if $1,700 be appropriated by Congress in accordance with the original estimate, it will be applied to recleaning out that portion of the river which has already been improved.

The work is not a permanent one, as obstructions are reforming, and is purely of local importance. It is not known that any benefits have resulted to commerce since the improvements have been made.

No work has been done during the past fiscal year, no appropriation having been made since that of July 5, 1884. The commerce at present for the past year was 725 cords of wood, 120 bales moss, 200 sacks wool, 1,500 bales cotton, 1,500,000 staves.

Money statement.

Amount (estimated) required for completion of existing project........	$1,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	1,700.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 3.

IMPROVEMENT OF TICKFAW RIVER, LOUISIANA.

This work was commenced in 1879 by an examination authorized by Congress. The estimated cost of the improvement was $10,230, and the project was to clean out this stream as well as its navigable branches, the Notalbany, Blood, and Ponchatoula, by removing such obstacles to navigation as snags, logs, stumps, and overhanging trees.

In 1881 Congress appropriated $2,000 to commence the work. Work was done by contract in 1882, and 16 miles of Tickfaw River was cleaned out. In 1882 $2,000 more was appropriated; this was expended partly in building plant, and the work of cleaning the stream was done with this plant and hired labor; the result was a good navigable channel 9 miles above the previous head of navigation on the Tickfaw. In 1886 Congress appropriated $2,000 more, the funds to be available for cleaning out the navigable branches of the Tickfaw. In the latter part of 1886 and early part of 1887 work was resumed with Government plant and hired labor; the result is the cleaning out of the branches and completion of the work in accordance with the original project at a cost less than the original estimate. Each of the streams, the Tickfaw, Notalbany, Blood, and Ponchatoula, were cleared of obstructions up to the head of navigation.

The improvement will not be permanent, as obstructions will again form in consequence of freshets and the careless felling of timber. As the project is now completed, further appropriations are not required unless Congress desires to have annual work done on either or all of these streams, in which event it is estimated that $1,000 per year will probably keep them all thoroughly cleaned out. At present this is not necessary, as all these rivers are now in good navigable condition. For more detailed information reference is made to Lieutenant Crosby's report.

The commerce on this stream for last year was estimated at a value of $140,000, carried by three schooners.

Money statement.

July 1, 1886, amount available	$3.72
Amount appropriated by act approved August 5, 1886	2,000.00
	2,003.72
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,713.68
July 1, 1887, amount available	290.04

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, LA., *March* 10, 1887.

SIR: I have the honor to report as follows concerning the work recently done on the navigable branches of the Tickfaw River, Louisiana:

This work originated in an examination authorized by act of Congress approved March 3, 1879. The report of this examination (Appendix M, Report of Chief of Engineers, 1880) presented an estimate of $10,230 for removal of obstructions in the Tickfaw and its branches, the Natalbany, Ponchatoula, and Blood rivers.

An appropriation of $2,000, made March 3, 1881, was expended on a contract, the execution of which began January 4, 1882, and the result of which, as reported in 1882, was the clearing of 16 miles of the Tickfaw. Another appropriation, made on August 2, 1882, was expended in the construction of plant and the doing of work by hired labor, resulting in clearing the Tickfaw to a point 9 miles above the previous head of navigation.

Your Annual Report of last year (1886) states: "The benefit to commerce resulting from the improvement of this stream (Tickfaw) is purely local. It would result in very little advantage to improve navigation any higher up. * * * It is therefore recommended that no further appropriation be made for the Tickfaw unless the money so appropriated can be applied to the branches referred to."

The next appropriation, $2,000, made August 5, 1886, was directed to be expended on the navigable tributaries. The plant previously used, and which had been paid for in part from appropriations for the Amite and Tchefuncte as well as the Tickfaw, was still serviceable; work on the Natalbany was begun, using this plant and hired labor, in September, 1886. All work needed on the Natalbany, and a part of the Ponchatoula work, was done by November 1, at which date you directed the plant to proceed to the Amite River, as the danger of freshets there was more imminent than in the Ponchatoula. The Amite work having been completed the party returned, beginning work on the Blood River February 9, 1887; all necessary work having been finished here, work was resumed on the Ponchatoula on March 5, 1887, continuing until to-day, when the work stops on account of exhaustion of funds.

On October 14 I inspected the Natalbany; yesterday, the Ponchatoula and Blood. The Natalbany is in excellent condition up to Springfield, a small village at the head of navigation. The Ponchatoula is in similar condition up to the landings nearest the town of Ponchatoula, a small village on the Illinois Central Railroad, 3 miles from the landings. Here the stream is quite narrow and tortuous. Nothing is to be gained by going further up, even if that were possible with ordinary expense, while, in fact, only a very large outlay could clear the stream.

The distance from the mouth of the Ponchatoula to the upper landing is about 4.5 miles. Work on the Blood extended to about the same distance above its mouth, and has resulted in giving a clear river to that point, beyond which, like the Ponchatoula, it could be made navigable only by an outlay entirely out of proportion to the interests involved. Indeed, it may be questioned whether the small sum already spent is not larger than the interests demanded. There are only three or four families living on this stream, which is bordered by dense swamps. They are but 3 miles from Springfield, on the Natalbany. Five or six times a year a small tug-boat ascends the Blood, taking out some saw-logs. This is the extent of its commerce. In making an examination, I reached the stream at three points by a combination of walking and buggy-riding; was unable to obtain even a pirogue, although I found one of the few habitations in the swamp.

The work on the three streams has been of the same character, pulling out snags and logs and cutting down overhanging trees. It has been well done and economically done. Some guaranty of thoroughness was had in the fact that Mr. Simms, overseer of the party, is owner of two of the four schooners that ply on these streams. In my opinion there is no further need of improving these streams. Their navigability is quite sufficient for two or three times the shipping found on them, and there is little promise that any such increase will take place within the next ten or fifteen years. As it has been heretofore reported of the Tickfaw proper (special report, July 11, 1885) that "this river has been improved to completion as far as commercial and navigation interests required," the whole project seems now to be finished, although only $6,000 of the estimated $10,230 has been appropriated. As these streams are thickly bordered by forests, it is not improbable that other obstructions will appear, but their navigability will be all that is required for several years. Carelessness of timber-men, who fell trees into the stream, is chargeable with much of the deterioration. The proper local authorities have been addressed on this subject.

In October I reported commercial statistics, gathered from reliable sources, as follows:

Annual export from Natalbany (three regular schooners)	$140,000
Annual export from Ponchatoula (one schooner nearly every week)	35,000
Saw-logs from Blood, Natalbany, and Ponchatoula	15,000
Total	190,000

These, I think, are outside figures. Imports will be of about same value. It has been previously reported that about two schooner trips per week are made on the Tickfaw proper. No figures were given for valuation.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 4.

IMPROVEMENT OF AMITE RIVER, LOUISIANA.

The original project for improving this river was adopted in 1880; the object was to obtain at low water a channel 5 feet in depth as far up stream as appropriations would permit, the main portion of the work to be done being above the mouth of the Bayou Manchac.

In 1880 Congress appropriated $8,000 for this work; contract was made for $7,650 for improving 40 miles of the river. In 1881 $5,000 more was appropriated. It was proposed to use this appropriation for extending the work beyond the point where the first contract should terminate. The accepted bidder for the second contract failed to furnish bonds, and the contract was not completed. The work under the first contract was accepted in 1883; the work was poorly done, and only resulted in cleaning out 17 miles of the river. In 1883 the project was modified and approved, so as to clean out obstructions below the Bayou Manchac with Government plant and hired labor. This part of the work was well and economically done, and resulted in cleaning out about 8 miles of river. The officer in charge of the improvement in 1884 estimated that to work over the 17 miles of river first done by contract and complete that required further down the river would cost $8,205.

In 1886 Congress appropriated $2,000. In November, 1886, work was resumed by means of Government plant and hired labor and continued until January 31, 1887, during which time 2,754 stumps, logs, snags, and overhanging trees were removed from the bed and banks of the stream. Most of this work was done between the mouth of the Bayou Manchac and Port Vincent, about 5 miles below, where the river had become almost unnavigable from the accumulation of snags and other obstructions since work was suspended in 1883. All serious obstructions to navigation below Port Vincent were also removed. The Amite River is now in good navigable state. Examinations showed that it was useless to spend any more money on the Amite above the mouth of the Bayou Manchac for the reason that there is neither commerce nor navigation above this point, and although steamboats have been 30 miles further up the river, there is no commerce to pay them for going up; besides, at low-water stages the depths are insufficient and at high water the current is too swift to be steamed with economy.

The small balance remaining of this last appropriation could only be expended on the Amite, not on its navigable branch, the Bayou Manchac; hence when that portion of the Amite which was navigable below the Manchac had been cleaned out, it would have been a waste of public funds to have spent the balance on the upper portion of the river. Work was therefore discontinued, owing to its completion in accordance with the modified project in January, 1887. The improvement will not be permanent; banks will cave, carrying in trees, snags will re-form, and to keep the river in good navigable condition will require annual work at an estimated annual expense of about $2,000.

The amount yet available ($333.33) may be applied in the future to removing obstacles, such as snags, that are certain to accumulate, but it is recommended that any future appropriation, if made for this stream, be so worded as to make the funds available for also clearing out the Bayou Manchac, the main branch of the Amite. Steamboats run up this bayou for about 8 or 9 miles to Hope Villa, which is the head of navigation. It is estimated that to remove obstacles to navigation in the Bayou Manchac, such as snags, stumps, and overhanging trees, will cost about $2,500. The products carried on this bayou are cotton, cotton-seed, wood, staves, shingles, lumber, hides, eggs, chickens, sugar, and molasses, annually valued at $136,000.

Total appropriated thus far, $15,000.

Money statement.

July 1, 1886, amount available	$1.99
Amount appropriated by act approved August 5, 1886	2,000.00
	2,001.99
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,668.66
July 1, 1887, amount available	333.33
Amount (estimated) required for completion of existing project	6,205.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	6,205.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 5.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

The original project for this work was adopted in 1879, from surveys authorized by act of Congress March 3, 1873 (see report of Chief of Engineers for 1874, Appendix S 5), the object being to improve low-water navigation of the bayou by removal of obstructions, such as snags, wrecks, raft heaps, cutting of trees, etc., which obstructed navigation.

On account of high water, operations were suspended December 31, 1881, and resumed September 21, 1882. From this time till January

31, 1883, the work was carried on steadily to a point 30 miles below Lockport, when, the funds being nearly exhausted and the water getting too high, the plant was taken to Lockport and laid up.

In the river and harbor act of August 22, 1882, provision was made for a survey of this bayou. A preliminary report on this was forwarded on August 20, 1882, and in Department letter of April 24, 1883, it was directed that the survey should be made.

No work was done during the year ending June 30, 1884, the balance of available funds being too small to permit anything more than the payment of a watchman for the care of the boats.

On August 25, 1884, an amended project was submitted by Captain Turtle for continuing work downward from where it had been suspended the previous year, and authority was received from the Chief of Engineers, under date of September 1, 1884, to carry on the work as recommended.

The work of overhauling the plant at Lockport was immediately commenced, and work was resumed September 22, 1884, and continued until January 15, 1885, when it was again stopped on account of high water, and the plant ordered back to Lockport and the crew discharged, except the sub-overseer and cook, who were retained for further service on Bayou Teche. The plant was at the same time placed under the direction and orders of First Lieut. O. T. Crosby, Corps of Engineers. By authority of the Chief of Engineers it was removed to Bayou Teche, serving en route as a quarter boat for a survey party on Bayou La Rompe. It has remained on the Teche since March, 1885, engaged most of the time in snagging and wrecking operations.

After completion of the survey of 1883 a study of the level notes showed them to be worthless. Without an accurate profile no plan could be made; hence, in April, 1886, the level lines were rerun under the direction of Lieutenant Crosby.

The commerce of Bayou La Fourche has been greatly benefited, the number of vessels having steadily increased as the obstructions were removed.

Before any work of improvement the bayou was so obstructed with snags, logs, and wrecks from its head at Donaldsonville to a point about 22 miles below Lockport, that during the low-water season flat-boats and luggers drawing about 2 feet were the only kind of vessels able to navigate. In some places, especially between Raceland and Lockport, a distance of 7½ miles, even this was difficult, the luggers having to lower sail and cordelle. But since the removal of obstructions, flat-boats and sailing-vessels of even greater draught have passed up and down without difficulty.

During eight months of the year, when the water is high, the bayou is navigable for large-size steam-boats.

During the past fiscal year the water was exceptionally low; steamboats could not get over the bar at the head of the La Fourche, and navigation by means of flat-boats was extremely difficult and irregular.

Should the project for slackwater navigation and dredging, plans for which were submitted in the last annual report, be adopted, it is then recommended that the entire estimated cost, viz, $450,000, be appropriated in one lump.

The cost of maintenance of slackwater navigation is estimated at $30,000 annually. The saving of freight paid in consequence of slackwater navigation if made is estimated at $19,000 annually.

The annual value of commerce of the La Fourche is about $3,000,000. The estimated amount of commerce is 22,150 hogsheads sugar, 27,705 barrels sugar, 45,274 barrels molasses, 907 barrels rice, 66,117 sacks rice, 9,341 barrels and sacks potatoes and onions.

Money statement.

July 1, 1886, amount available	$254.61
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	175.00
July 1, 1887, amount available	79.61

S 6.

IMPROVEMENT OF BAYOU TERRE BONNE, LOUISIANA.

In 1879 Congress ordered an examination of this stream. The estimated cost of improvement in 1880 was $18,800. This was for dredging and removing logs, snags, and other obstructions. As the examination on which this estimate was based was made in high water, it was incorrect, and the same officer making the first estimate increased it by $20,000, making the total estimate $38,800.

Appropriations made are as follows:

June 14, 1880	$10,000
March 3, 1881	8,800
August 2, 1882	7,000
August 5, 1886	10,000
Total	35,800

Dredging was commenced in 1880; was continued in 1881 at a point about 23½ miles below Houma, La. This was contract work, and about 7½ miles of channel was improved. In 1882 work was resumed with Government plant and hired labor, and completed to within about 10½ miles of Houma. In 1886 work was again resumed by Government plant and hired labor, and about 164,165 cubic yards were dredged out and 4.1 miles advanced.

The Government dredge is doing excellent work at a cost of about 4 cents per cubic yard for dredging. The bayou between its low-water banks is of less width than the dredge-boat; consequently, to do any work, she has to first cut a channel of her own width and then has to cut turn-outs or passing places every few hundred yards to enable floating, sailing, or steaming craft to pass. When this improvement was commenced, the Bayou Terre Bonne was in places little more than a drainage ditch. When the dredge began work the bayou was but 11 feet wide. Nearly every plantation on the bayou has a drainage ditch emptying into the bayou, and below the mouth of each ditch a bar is formed so that work done by the dredge one year is frequently obliterated during the next. The improvement enables planters on the bayou to float their produce to Houma, the nearest railroad station, instead of hauling it there over wagon-roads, and it drains the neighboring country. The improvement, if completed, will never be permanent unless the drainage ditches emptying into the bayou are closed and the drainage turned towards the swamps.

The products raised on the Terre Bonne consist of sugar and molasses, estimated during the past year at a value of $967,500. To get this product to market over 72 miles of railroad, the cost is asserted to be $91,875, or nearly 10 per cent. of the value of the crop. To complete this improvement to Houma, La., will cost $3,000 in addition to what is now available, and to maintain this channel will require annual dredging estimated to cost $1,000.

Money statement.

Amount appropriated by act approved August 5, 1886	$10,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	6,108.87
July 1, 1887, amount available	3,891.13
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 7.

IMPROVEMENT OF BAYOU BLACK, LOUISIANA.

Examination of this bayou was ordered by act of Congress of June 14, 1880.

Preliminary examination was made in January, 1881, and a partial report made February 2, 1881, full report being prevented by the failure of the employé who made the examination to submit report, though frequently directed to do so. On March 3, 1881, $10,000 was appropriated for this work.

With the annual report of 1881 was published a full report of a preliminary examination made by an assistant engineer, in which the condition of the bayou, as indicated below, was clearly represented. Appropriations made in 1882 and 1884 amount to $25,000.

In an inspection of this bayou made in April, 1885, I made notes and observations, and on them base the following report and deductions:

From the village of Tigerville to the spot where the dredge is at work, about 10 miles above, the Bayou Black has now a depth of 5 to 6 feet of tide-water. The width of this water-way varies from 45 to 100 feet. The greater portion of this 10 miles has been worked over by the dredge, and the last 4 miles is practically a canal in the bed of the bayou, which has been dug by the dredge. As fast as the digging progresses, the ditch or canal which is being dug becomes filled with tide-water; but that portion of the bayou in front of dredge is so filled up with sediment, grass, logs, roots, and stumps, and contains so little water, that at present it is impossible to float the lightest skiff.

When the examination was made in April, 1885, and resulted in a stoppage of the work, principally because the appropriation was about exhausted, I doubt if there was 50 gallons of water per minute flowing in the bayou, and a few days before this the ground in front of the dredge was so hard that it became necessary to hire 4 mules and a plow to break the ground so that the dredge could work. In fact, following the rank, tall grass growing in the old bed of the bayou is the practical method of tracing its course.

From the point where the dredge has now stopped working to the town of Houma, via the line of the bayou (the proposed improvement), is 14 miles in length. The bed of the bayou is filled up with mud and obstructions very nearly to the level of the roads on each side of it; so that to complete the work contemplated will yet practically require the digging of a canal 45 feet wide by 6 feet deep by almost 14 miles in length.

The muck, etc., thrown out of the canal is so oozy or semi-fluid that much of it will run back into the canal, and it is probable that a pile and timber revetment may have to be built over a considerable portion of the route to prevent this.

On each bank of the bayou is a wagon-road 25 to 40 feet in width, just beyond which are the fences of plantations and small farms. The muck must therefore be thrown on the road, obliterating that on one side, perhaps on both, making either of them for the time being almost if not entirely impassable.

When the canal or ditch shall have been completed to Houma it will enable small boats (probably flat-boats) to carry sugar and the material products of the country from the plantations bordering on the bayou from Tigerville to Houma, an extreme distance of about 24 or 25 miles.

The estimate for completing this improvement, by Major Howell, in 1881, was $47,520. Of this amount nearly $25,000 has been expended, of which about $4,500 was used in part payment for the building of a dredge-boat to be used in cutting the canal. This would leave $20,000 expended in actual dredging about 10 miles of bayou, a considerable portion of which was already open bayou, and between 14 and 15 miles of bayou yet to be opened. The average quantity of material to be removed in each mile of cutting I estimate to be nearly double what it was in the preceding 10 miles already opened, and therefore estimated the cost nearly twice as much, or $4,000 per mile. As there are yet about 14 miles of cut to be made, the estimate for completing this cut should be 14 times $4,000, equal $56,000. This, together with the $25,000 expended, would be $81,000, an excess of $33,480 over the original estimate for completing the work. It is barely possible that this estimate for completion may be too great, but when the sunken, embedded logs, stumps, roots, thrown up by the dredge all along the embankment, are seen, no prudent engineer would submit a smaller estimate, and I feel warranted in saying that no contractor would make a contract to do the work required even on this estimate. Moreover, in pushing the work to advantage, the engineer in charge of this improvement has never estimated less than $10,000 to be necessary for any one year's work.

Suppose the remaining 14 miles were cut to Houma. Here, by reopening an old canal, now deteriorated into a shallow ditch, connection may be had with the Bayou Terre Bonne. The cut is about 1 mile long. Suppose this done, and the Terre Bonne improvement completed to this point also, the result would be that planters along the Black and Terre Bonne could use these connected canals (for such would the bayous be) to get their products to the railway station, whence by rail to New Orleans, about 70 miles, or to ship by water through Bayous Terre Bonne and Black, Bayou Chêne, Bayou Bœuf, Atchafalaya River, and Mississippi River to New Orleans, about 400 miles.

It is reasonable to suppose that the railway rates for carrying freight less than 70 miles should be less than that of water routes nearly six times as long. The advantage to the planter in having the improvement made is, therefore, simply the saving in cost and time to him in his transportation or hauling his product from his plantation by wagon or by canal to the nearest railway station.

On or near the Bayou Black, and 25 miles apart, are two railway stations, Tigerville and Houma; therefore the longest haul to nearest station would be 12½ miles, or an average haul of 6¼ miles.

Is the Government justified in cutting a canal, for that is just what is being done in improving Bayou Black, the lowest estimated cost of which is $47,520, for sake of saving to the planter the difference between 6¼ miles of wagon and canal transportation?

The improvement at its best is simply a local one and only benefits the people on or near the bayou, and can in nowise be considered a public necessity, but as it has been begun by authority of Congress and $25,000 has been spent on it, if the work were now stopped the greater portion of this money would be wasted. It is therefore assumed that the work will be continued to completion, and in this event no less than $10,000 should be appropriated for the fiscal year ending June 30, 1889. On September 27, 1886, the dredge-boat used in the improvement of Bayou Black, was, on account of exhaustion of funds, transferred to Bayou Terre Bonne, Louisiana, to be used in the improvement of that stream.

Money statement.

July 1, 1886, amount available	$431.81
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886	112.50
July 1, 1887, amount available	319.31
Amount (estimated) required for completion of existing project	56,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

A condensed history of this work is contained in the last annual report. With the funds available at the end of the last fiscal year, viz, $7,317.93, work was resumed above Breaux Bridge in the latter part of 1886 by a party on the wrecking flat and a large land party. In consequence of low water, operations by the party afloat had to cease in October, and the land party completed their work up to Port Barre, the headwaters of the Teche, in December, 1886.

The result of this year's work was the removal from the channel of 1,376 snags, logs, and sunken trees, the removal by blasting of 133 trees and stumps, and the cutting down and removal of 4,325 overhanging and other trees from the banks that were obstructions to navigation. The Teche is now opened its entire length from its mouth to Port Barre, and all is now done that can be done for the stream preparatory to the actual construction of a lock and dam for slackwater navigation, estimated to cost $175,000, a detailed description of which appeared in the last annual report.

Should Congress decide to make slackwater navigation on this stream, the total amount estimated for should be made in one lump. The improvements thus far made, which have cost about $44,880.66, have improved navigation materially, but have not produced any increase of commerce nor reduced the freight rates in this section. The estimated annual value of the sugar crop on the Teche is between $3,000,000 and $3,500,000, only about one-tenth of which is marketed by water transportation. If slackwater navigation be made, it will only benefit that part of the Teche country above the lock, the value of the estimated annual product of which is $258,725.

The report of Lieutenant Crosby herewith shows the condition of the stream after work was completed in 1886:

Money statement.

July 1, 1886, amount available	$7,317.93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	6,735.85
July 1, 1887, amount available	582.08

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, LA.,
December 16, 1886.

SIR: I have the honor to report as follows upon an inspection of the work on Bayou Teche, made yesterday under recent orders from you.

Since my last inspection the work had extended up-stream about 10 miles, and on yesterday the last mile of the bayou was cleared of its worst obstructions.

Anticipating the exhaustion of funds, Mr. Oliver, overseer in charge, was several weeks ago directed to diminish the width of the clearing, in the hope of securing at least a barge channel through to Port Barré, the point where the head of the Teche is found, an outflow from the Courtableau. By hard work on the part of Mr. Oliver and his men this was practically accomplished.

Finding on yesterday morning that the thorough clearing had reached a point about 1 mile below Port Barré, I directed that the force be distributed throughout this mile, cutting the most troublesome trees in the channel. Snags in this part of the stream are scarcely an obstruction, as the bar near the Courtableau prevents the entrance of water until it has reached such height as to cover the snags to a much greater depth than the draught of any boats running here. An examination of the mile to be worked over showed it to be unusually clear of obstructions, so that one day's work of the whole force was sufficient to put it in order.

Near the lower end of this mile is a bridge. Last year a small steam-boat, 85 by 20 feet, came out of the Courtableau to this point, and would have gone through the draw, except that an arched beam thrown over the draw struck the smoke-stack. The draw was made with a view to barge navigation, which is the only kind that has been seen on this portion of Bayou Teche in many years. The improvement has resulted in giving a good barge channel from Port Barré to a point about 8 miles down stream. Below that is a steamboat channel throughout the whole length of the stream.

At a point about 10 miles down-stream from Port Barré there is a closed bridge which would at present prevent a steam-boat or at very high stages even a barge, from passing. I consulted the president of the police jury of the parish about this matter, and was assured by him that at the next meeting of the jury, to be held in two or three weeks, the construction of a draw would be ordered. This is now the only closed bridge on Bayou Teche. In speaking of the existence of a channel throughout the stream, it is to be understood that this refers only to seasons of high water. Before the improvement was begun, the first 30 miles of the stream below Port Barré was extremely difficult to navigate even by very small steamboats at high stages, the channel being much obstructed by standing and leaning trees, snags, and logs.

Now, at same stage, an ordinary steamboat, say 175 by 30 feet, could ascend to within 10 miles of Port Barré, and 2 miles further were the closed bridge opened. It is unfortunate that the season of high water begins so late as to render it useful for handling only a small part of the crops. Yesterday there was not enough water in the Upper Teche to permit my examination to be made in a perogue; at the same time I was informed by those familiar with the facts that about two-thirds of the crop had already been taken out of the vicinity of Opelousas. Perhaps the planters living on the banks of the stream have held a little larger portion in the hope of an early rise.

The Upper Teche will be navigable when the Courtableau rises high enough to pour a considerable volume over the bar referred to above. Such a stage may begin in a few weeks and may last several months, but will be too late to handle a large part of the crop. All the year navigation can be had only by locking, plans for which have already been reported to you. The amount of navigation on the Upper Teche will be watched during the coming high-water season by competent parties. Mr. Oliver has worked faithfully and intelligently, and I can heartily recommend him to your confidence. The only point of criticism that suggested itself to me was in this: That a few of the logs and trees were not removed quite as far up the bank, out of reach of high water, as seemed desirable to me. The force was disbanded yesterday; stores and all other property remaining on hand were shipped to New Iberia, where they will be taken on board the repaired snag-boat now ready to start for Bayou Pierre, Mississippi.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant Engineers.

Major W. H. HEUER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

GENTLEMEN: Having been appointed by you to ascertain the commerce of your parish, and especially of the Bayou Teche, I beg leave to submit to you my report.

To enable me to perform the duty required of me it was necessary for me to visit all portions of your parish, see the people personally, and get all the information possible, so that I would not only be able to give you the commerce of 1886 but also that of 1887. This I have done, and given you as reliable a report as was possible for me to make. I have given the names and of what each one has made, ginned, or shipped. Then I have consolidated the whole so that you can see the amount of each commodity and the price I have put on it, and judge for yourselves as to its correctness.

I find that the commerce of the parish for the year 1886 amounts to $1,859,999.90; the exports to $909,044.10, and the imports to $950,955.80. For the year 1887 I find that the commerce will amount to $2,686,102.36, judging from percentage of increase in acreage and condition of crop.

All of this commerce is either directly or indirectly interested in the navigation of Bayou Teche and of its improvement. I can say for the people residing on that portion above Saint Martinsville to Breaux Bridge, Arnouldville, and Port Barré, that it is a matter of vital importance to them. They have only two small steamboats running in the trade. I am informed by the owners and captains of the boats that the steamer *Danton* makes two trips a week in high water this year for about two months; for the balance of the year, when there is water enough to get to Breaux Bridge, one trip per week. When there is not, she makes occasional trips as high as she can get up, and then has to discharge her cargo and ship in small flatboats. The steamer *Alice* makes fifteen or twenty trips a year during high water. The steamer *Durio* makes some four or five trips a year for cotton-seed for the Iberia Oil Mill.

The charge for freight is one-half of what is charged by the round-boats to the city of New Orleans, which is 33⅓ per cent. less than the railroad charges.

Notwithstanding this, much the greater portion of the freight goes by the railroad for the want of facilities to ship by the river. These are the facilities these people have to get their produce to market. Above Breaux Bridge, to Arnouldville and to Port Barré, they have no navigation the greater portion of the year, in consequence of which they have to haul their produce considerable distances, to either Port Barré or Grand Conteaux Station, on the Morgan Railroad. This, too, when they have a beautiful bayou at their very doors, which can be made navigable at their doors at a small expense.

In addition to the commerce I have given there is, I am informed by Messrs. Bergeron & Rogers, brokers, nineteen cotton-gins between Arnouldville and Port Barré, also five sugar-houses, which will swell the commerce of the Upper Teche to over $1,500,000, which was a short-crop year and will probably double that this year.

The country is one of the most beautiful in Louisiana. The lands are high and rich, although of alluvial formation, requiring no costly levees for their protection. They are well adapted to the cultivation of sugar, cotton, rice, corn, and tobacco; also to fruit and gardening. It is a fine stock country and stock-raising could be made very profitable.

This country is already occupied by an industrious and thriving population. If they had proper facilities for getting their produce to market, would in a short time increase their commerce five if not ten fold.

In view of the extensive commerce now existing and of its great capacity for development, of the necessity of the work and its great convenience to the people, is it too much to ask the Government to make the necessary appropriations, or to call on our Senators and Representatives in Congress to exert themselves in favor of this measure?

It will not be very expensive. The bed of the Teche is not much above tide-water. One lock at or below Saint Martin's and another near Arnouldville, to hold the water, and a little dredging will be all that is required.

E. T. KING.

Hon. POLICE JURY, PARISH OF SAINT MARTIN'S.

[Extract minutes of the police jury of the parish of Saint Martin's.—Meeting held on July 5, 1887.]

On motion of Mr. Duchamp, seconded by Mr. Gillard, voted and carried, the following resolutions were unanimously adopted:

Resolved, That we have carefully examined the report made to us this day by Capt. E. T. King; that we find the report correct. That the thanks of this police jury and of the people of the parish are due to him for the able manner he has discharged the duty we have imposed on him, and we hereby extend the same.

That Captain King be requested to forward this report to Maj. W. H. Heuer, Engineer U. S. A., to be forwarded by him to the Chief Engineering-Department at Washington, and through them to the Congress of the United States.

Resolved, That Major Heuer, in making his report to the chief department at Washington, be respectfully requested to make it as favorable to the improvement of the Teche as represented by the report of Captain King to this body.

Resolved, further, That our Senators and Representatives in Congress be also requested to give this matter their early attention and exert themselves in favor of getting the appropriation necessary for the work.

A true copy from the minutes.

AUG. MARAIST,
M. Clerk P. J.

Commodities.	Quantities.	Price per unit.	Total value, 1886.	Average increase.	Condition increase.	Value, 1887.
Exports.						
				Per cent.	*Per cent.*	
Centrifugal sugar .....pounds..	1,502,627	$0.05	$75,131.35	65	35	$155,262.70
Kettle sugar ....do....	1,173,500	.04	46,948.00	65	35	93,896.00
Centrifugal molasses ..gallons..	70,850	.25	17,712.50	65	35	85,425.00
Kettle molasses ....do....	59,605	.35	20,861.75	65	35	41,723.50
Cotton ....bales..	10,685	45.00	480,825.00	20	30	721,237.50
Cotton seed ....tons..	4,118	8.00	32,944.00	20	30	49,416.00
Cotton-seed oil ....barrels..	2,200	17.00	37,400.00	20	30	56,100.00
Cotton-seed cake and meal. tons..	1,300	18.00	23,400.00	20	30	35,100.00
Lumber shipped ....feet..	500,000	15.00	75,000.00	....	....	75,000.00
Eggs ....dozen..	215,480	.10	21,584.00	....	....	21,584.00
Mules and horses..............	....	....	10,025.00	15	20	13,533.00
Hides.........................	4,925	1.50	7,387.50	....	....	7,887.50
Poultry ....dozen..	4,285	3.00	12,855.00	....	....	12,855.00
Moss ....bales..	1,200	6.25	7,500.00	....	....	10,000.00
Cattle and stock	....	....	2,720.00	....	....	2,720.00
Esculents, potatoes, etc........	....	....	1,750.00	....	....	1,750.00
Articles not enumerated or omitted	....	....	35,000.00	....	....	35,000.00
Total	....	....	909,044.10	....	....	1,367,900.20
Imports.						
Lumber in log ....feet..	2,108,000	8.00	168,640.00	....	....	168,640.00
Machinery.....................	....	....	39,600.00	....	....	39,600.00
Stone coal	....	....	15,480.00	....	....	15,480.00
Necessities, luxuries, and farming implements, etc., 80 per cent. on exports	....	....	727,235.80	....	....	1,094,392.16
Total commerce, exports and imports............	....	....	1,859,909.90	....	....	2,686,102.36

This amount can be expended in the year ending June 30, 1889.

The commerce of the Courtableau carried by water last year is reported to have been 3,800 hogsheads sugar, 6,600 barrels molasses, 1,600 tons cotton-seed, 8,200 bales cotton, 250 sacks rice.

Money statement.

July 1, 1886, amount available	$338.85
Amount appropriated by act approved August 5, 1886	5,000.00
	5,338.85
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,436.69
July 1, 1887, amount available	2,902.16
Amount (estimated) required for completion of existing project	12,107.90
Amount that can be profitably expended in fiscal year ending June 30, 1889	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, LA., *September* 4, 1886.

SIR: I have the honor to report as follows upon an examination of Bayou Courtableau, made September 2, 1886, under your orders:

The stream is now at a very low stage—not the lowest, but ordinary low water. Starting from Port Barré in a skiff, I observed that Bayous Teche, Little Juramon, Juramon, and another small bayou are dry at their heads. Big and Little Cam, Mamselle, and English Bayous have water within their banks, but apparently absolutely still. Another small bayou shows a little water at its head, but slashed trees dam it. The bayous named with the two Fordoches, upon which work was done last year, constitute all the outlets of the Courtableau from Port Barré to the bar. The dam constructed at Big Fordoche, about 3.5 miles above the bar, is in good condition, the water below, swamp drainage, being 5 feet lower than the Courtableau.

The only injury caused by the last flood season is a caving and washing away of earth in front of one end of the dam, where it is run out on a sloping bank, well above water now, but just covered by water rising to the crest of the part of the dam crossing the stream. Probably on account of difficulty in using the pile-driver here, the sheeting is placed, three planks deep, horizontally against piles. To spike them on, a slight excavation was made. It was probably this disturbance of the natural surface which caused a wash to be made here when the current was very strong. The excavation is about 16 feet long, 3 feet wide, and 2 feet deep. It does not continue to the low-water bank, hence permits no water to pass now, but should be filled and packed before the next high water.

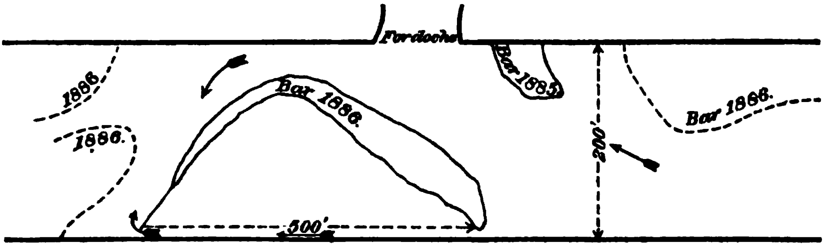
The Little Fordoche dam, though much wrecked, has caused much change in the condition of the bayou. Commencing with the lower line of piles, those that received the braces from the main line, they have disappeared, some by being buried in the sand, others by being pulled up.

What was originally the principal line of the timber dam appears in three pieces, one from each flank, one near the middle of the stream.

These are inclined down-stream from the vertical. The two intervals aggregate about 12 feet, and the upper line of sheet-piling, intended to cover cracks, has disappeared. The parts remaining are supported by their penetration into the sand and by tie-pieces coming from another line of piles, driven up-stream of these when the disaster to this dam occurred just after its completion. This upper line of piles penetrated further into the clay bottom, here overlaid by about 10 feet of sand, than the others.

To the tops were attached the tie-pieces spoken of, and up-stream they were made the support of a brush and dirt dam. Much of this brush and earth was washed away during the flood, but the part of the brush remaining has been re-enforced by other drift, and a very considerable deposit was caused just above. About 20 feet above this line a temporary dam was built last year; what was then a basin is now filled up nearly to an average level equal to the present height of water. The steamboat men have built this year another little dam, sufficient to check the small outflow that would occur through the now much-impeded channel. From this point up to the head of the bayou, a distance of about 400 feet, considerable shoaling has taken place. At the head the shoaling has reduced the cross section, at present stage, to about 20 square feet. Water above the dam is about 2 feet higher than that standing in a pool below, while below this pool the bottom again rises, due to deposit induced by logs, so that the flow is only through an area of a few square inches.

Little Devil Bar itself, in the neighborhood of this bayou, has been much charged. The head of the bar now is about 600 feet above the bayou, an advance of about 500 feet. The changes are roughly shown in this sketch.



While these changes at the head are easily remarked, the general condition of the bar is about as before. A tolerably rapid current of small cross section runs over its whole length, wandering from side to side. A skiff can not pass without dragging. I should judge the cross-section area to be about 40 square feet. With these facts in view it may be well to make some inquiry into the argument bearing on this improvement.

(1) Even if the works now contemplated were completed, a bar would annually reform, for the bar is a high-water formation, and at high water the conditions are not materially to be affected by the works contemplated. The confinement of the Courtableau flood is not attempted.

At high water the crest of the dams is several feet below the general water-level; hence, only a partial check is given in the bayou discharge, while the bank discharge remains as before. This slight check can not raise the level of the Courtableau more than a few inches near its mouth, not by any means sufficient to prevent the great inrush of Atchafalaya water when that river is at flood. Let us suppose even the greatest change in conditions which the project could bring about, namely, the *complete* washing away of the bar during low water. At the subsequent high water, the Atchafalaya and Courtableau would only the more readily approach equality of level, since the discharge of the Courtableau has been facilitated, and afterward the Atchafalaya flood would enter the more rapidly, the present obstruction being removed. The inflow over the northern banks of the Courtableau from the swamp would be unchanged, and, finally, the slight check to relief through southern outlets would only tend to increase deposit from an increased volume. It can not be known whether, in case of complete removal of the bar, subsequent deposit would reach the dimensions of to-day.

(2) The season during which most efficacious work is done by the current has already past for this year; that is, the time of subsidence of the general flood. It is then that the least checking of the Courtableau current due to Atchafalaya influx is felt. Consequently, the conditions of bar formation will be much the same during the coming high-water season as during the past, the bar being as large as ever, and attacked only by a low river. Much was done during the past season toward a closure of Little Fordoche, the growth of the bar above it, together with the deposit between its banks, showing the large influence of even a poor dam. This process, continued another year, will probably destroy the Little Fordoche as an appreciable outlet. It should be remembered that in this stream, within the range of the muddy Atchafalaya water, a very imperfect dam may eventually, by inducing deposit, be as effective as a good dam in the streams further up, which carry but little sediment. In spite, therefore, of the poor condition of the Little Fordoche dam, I would, for the reasons above given, recommend that nothing be done in this stream save the slashing of trees. It is in this stream that such work is most effective. In case of any temporary rise in the Courtableau, from which cutting on the bar during this season might be desired, the earthen dam might be sufficiently strengthened by a few hours' work.

(3) It is not known that the Courtableau current, even after all the concentration to be effected by contemplated dams, will be able to cut a navigable channel over the bar. The examination just made shows that with the water at a stage about 4 feet higher than now the Big Fordoche carried off no water; the Little Fordoche carried much less than in past years; these are, rather they have been, the principal outlets,

and yet the channel across the bar is about the same as at the same stage last year. How much greater the effect would have been had all loss of water through outlets been prevented, it is impossible to say. The results of this year, however, are such as to suggest that the current may need some help, in the way of loosening the sand, before it will be able to cut a navigable channel. It is to be remembered that as this cutting continues, the lowering of the pool above the bar will diminish the velocity, until low-water level of the Atchafalaya having been very nearly reached, there will be only the very small outflow necessary to carry off summer drainage.

Before navigable depth has been cut over the bar, it may be found that this amount, such as is flowing now, may be delivered through the enlarged cross section with a velocity too small to permit any further cutting of the packed sand. I would therefore recommend that an artificial loosening of the sand be considered as a probable part of future operations.

(4) The lowering of the Courtableau, in case of success at the bar, was referred to in reports made some years ago. The survey made in 1880 shows that an extension of Atchafalaya low-water level as far as Port Barré leaves barely 5 feet depth at that point, while above this could not be found, and the large boats would probably go no further. The construction of locks, extending navigable depth to Washington, was contemplated in the original plans. It is now known that such constructions would be much more costly than was then estimated; the probability of their future existence is rendered correspondingly smaller. Considering this, the wisdom of lowering the Courtableau, and thus causing a transfer of goods for Washington at Port Barré instead of Little Devil Bar, may be questioned. It can only be answered that the small commerce of Port Barré would be entirely freed from detention, while the transfer of Washington goods would be much easier than now. The steamboat men seem anxious to get over the bar, whether they can go on to Washington or not. If in spite of the fact that no certain results can be promised, the project be continued on its probability of success, then the plant now at Port Barré should be set to work as soon as possible.

A considerable bill of lumber was bought last year for Bayou English. It is on the bank at Port Barré, in good condition. The quarter-boat itself needs only slight repairs. The engine for the pile-driver was sent to the work to which it belongs.

In constructing the dams for English, Mamselle, and other bayous, large discretion as to detail must be left to the immediate superintendent of the work.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieut. of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 11.

IMPROEVMENT OF CALCASIEU RIVER AND PASS, LOUISIANA.

In 1874 and again in 1882–'83 dredged channels were cut through the flats in Calcasieu Lake above Calcasieu Pass. The dredged channel was 8 feet deep and 70 feet wide by 7,500 feet long. The work was done by contract.

In 1885 this channel had again shoaled to a depth of 3½ feet, and needed redredging, but by an unfortunate wording of the appropriation, "Improving Calcasieu River," could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and the river. Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 120 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet in width and 6 feet in depth, the excavated material to be thrown outside of the revetment walls. In addition to this another bar at the mouth of the Calcasieu River, at the northern end of the lake, was giving occasional trouble, and the same contract also required the excavation of a channel through this bar to be 100 feet wide by 6 feet in depth.

Work was commenced on the revetment walls in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness originating from exposure on this work.

In the spring of 1887 work was resumed by the administrator of the late contractor, and at the end of the year the piling is nearly all driven, 6,111 feet on east side and 7,297 feet on west side, and the planking on this revetment is nearly all completed.

The contractor expects to have a dredge at work in a few weeks, and it is thought that with the money available the work on these two bars, the only serious obstructions to navigation, will be completed.

The work will not be permanent, but it is thought that the improvement on the lower bar will last much longer than heretofore, on account of the revetment walls which were designed to prevent the sea from washing the excavated material back into the channel. The commerce passing through Calcasieu Pass and River is estimated at about $375,000 per annum.

It comes from the town of Lake Charles, La., where the annual cut of lumber is estimated to be worth $750,000, about one-half of which is sent away by rail. The total estimated value of commerce and navigation, which the improvement is designed to benefit, is estimated at a value of $1,209,250.

In consequence of a competing water route to market, the rates of freight on lumber by rail from Lake Charles to Texas ports are about $2 per 1,000 feet less than at other localities where the railway haul is less.

The money available will complete the cuts and work herein referred to.

I append report of First Lieut. O. T. Crosby, Corps of Engineers, giving commerce statistics.

Money statement.

July 1, 1886, amount available		$19,180.71
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,934.91	
July 1, 1887, outstanding liabilities	14.43	
		1,949.34
July 1, 1887, amount available		17,231.37

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, LA., *December* 16, 1886.

SIR: I have the honor to report as follows on the commerce affected by improvement of Calcasieu River and Pass, also expenditures actual and probable.

For Calcasieu River three appropriations have been made, aggregating $16,500, the dates of which are 1881, 1882, and 1884. Of this sum only $244.54 has been expended, it having been found that no improvement on the river was desirable before improvement of the pass had been effected. Congress at its last session, therefore, ordered the transfer of the whole appropriation, which had been diminished only by the cost of examinations, given above, to Calcasieu Pass. No money is required for Calcasieu River, either for completion or mainteinance of an improvement.

Commercial statistics will be the same as those hereafter given for Calcasieu Pass.

For Calcasieu Pass appropriations have been made, as follows:

June 10, 1872	$15,000.00
March 3, 1881	12,000.00
August 2, 1882	3,000.00
August 5, 1886, by transfer, as explained above	16,255.46
Total	46,255.46

Up to beginning of the present fiscal year the sum of $27,074.75 had been expended on this work.

With this expenditure a channel over the bar at the head of Calcasieu Pass was twice dredged, once in 1874, once in 1881-'82. On the present project, that of redredging and revetting the same cut, the amount of $713.66 has been expended, making a total up to date of $27,788.41, and leaving a balance available of $18,457.05. No more than this will be required for completion of present project.

It is difficult to state what the annual cost of maintenance will be. Assuming that until it rots the revetment will keep the channel clear, and that the revetment will last at least four years, and that the whole work must then be done over at present figures, the average annual cost may be placed at $4,000.

From reports made to the Chief of Engineers about the time when the first cut was made, it is learned that lumber was almost the sole product put on the market in this region, and that the fifteen mills then running produced annually about $390,000 worth of lumber. About forty-two schooners, averaging 50 tons burden, four steamboats, and one tugboat were engaged in this trade. The improvement increased the available depth from about 3.5 feet to nearly 6 feet, and permitted, certainly aided, in the extension of business shown in the discussion of

PRESENT COMMERCE.

Lumber is still the only industry largely developed. Ten large saw-mills produce annually about 100,000,000 feet of lumber, valued at $960,000.

It will be observed that this figure is in excess of that given by an investigation made about two years ago by about $200,000.

Reliable parties were carefully consulted in both cases. Since the report of 1884 several of the largest mills near Lake Charles have by improved machinery increased their capacity. This will account for a portion of the discrepancy; the remainder is such as is to be expected in an inquiry not made by rigid examination of books, but from the memory of ten or more individuals. Save in two or three instances, the figures for each mill were obtained directly from the managers. These 100,000,000 feet of lumber are sold chiefly in Texas, Galveston and Corpus Christi, being prominent purchasing points. Because of water competition, so I was informed, rates to Galveston by rail have been reduced from $5.50 per M to $3.50, which is also the water rate. Therefore while only from one-third to one-half of the cut now goes by water (the proportion has lately diminished because of deterioration of the channel), the millmen hold that the existence of the 6-foot water route saved them $2 per M on 100,000,000 feet or $200,000 per year. The cut now being dredged for the third time, and vetted for the first, has recently shoaled so much, that but for the present work it was feared that the water route as a live competitor would cease to exist.

Besides the lumber mills, two shingle mills cut about 26,500,000 shingles, valued at $66,250 per year.

The shipment of stock reaches 3,000 per year, which at $18 per head give a valuation of $58,000. It was estimated that nearly as many more are permitted to perish on the prairies, because, being of a poor class, they can not be profitably shipped at rail rates—$5 per head to New Orleans. Stock shipments can not now be made by water, because this class of freight requires vessels of deeper draught than can now be admitted over the bars.

Of agriculture there is as yet very little. Small quantities of rice, cotton, and oranges will aggregate perhaps $50,000 per year in value.

A considerable portion of the shipping used in carrying lumber from Lake Charles is owned by residents; the freights paid to this portion are therefore to be considered a part of the annual produce of the country. I have no exact figures on this point, but estimate these earnings to be about $75,000 out of $465,000 total freight bill on annual exports.

The annual produce of the Calcasieu region is thus found to be:

Lumber	$960,000
Shingles	66,250
Stock	58,000
Agricultural products	50,000
Freights	75,000
Total	1,209,250

It is to be noted that, on account of the nature of the products, the freight bill of this region is a very large one—about 33 per cent. of the value of the goods. Hence the question of transportation is one of unusual importance. Any saving in this matter would doubtless be divided in varying ratio, according to conditions at point of consumption, between producer and consumer, and would thus be a widely disseminated benefit.

Nothing has been said concerning freight on imports, these being handled almost entirely by railroad, and rates being almost, if not quite, independent of water-routes. Galveston is at present the only selling market which is at the same time a buying market, and the goods bought there are such as are preferably shipped by a quick route. Should steam navigation ever be established, it is probable that imports from Galveston, and perhaps other points, would come by water.

PROSPECTIVE COMMERCE.

It would seem that a very considerable development of commerce in this region is only awaiting better water transportation. There is an area of about 3,700 square miles tributary to this stream, Calcasieu River, and its branches. Of this about 1,600 square miles are timber lands, about the same number are grazing or agricultural land, and 500 square miles are sea marsh. The timber lands when cleared of course become agricultural lands.

The timber is principally pine. To indicate what is expected in the future, it may be mentioned that 235 square miles of timber lands are now held by a Michigan company, running one of the largest mills. Other mill-owners hold large tracts. They claim that within a few years their cut would be doubled if the proposed outer-bar improvement, admitting vessels of 11 or 12 feet draught, were completed. Besides giving them new markets, it is claimed that there would be a saving of $2 per thousand in shipping to present markets. Thus, taking the average schooner cargo to Corpus Christi, 50,000 feet, at $6 = $300, suppose the capacity doubled, 100,000 feet, at $4 = $400.

The heavier vessel will require but one more sailor, costing, say, $50 per month. The trip is made in about one month. Hence on the larger vessel there is received at $4 per M $100 more per trip, while expense is increased but $50 as compared with the present draught, about 6 feet.

Even on the present cut there would therefore be a saving of something like $200,000, supposing the railroad to come down to possible water-route figures rather than lose the trade. Should the cut be doubled, the saving over present rates would be $400,000. As an evidence of the fact that the business would largely increase with heavier vessels, it was stated to me that recent orders from South America and Mexico had been refused, while perhaps 15,000,000 feet lumber lie in the yards around Lake Charles. The long and dangerous voyages can not be undertaken at paying rates by the small vessels now in the trade.

The saving on the present cut of shingles, proportioned as above, would be about $5,300 per year. Of the 3,700 square miles referred to above, perhaps 2,500 square miles are held by a single company, while their entire holding, as reported to me by the officers of the company is about 2,100,000 acres, or 3,280 square miles. A portion of this lies near the Mennentau, a stream to the east of Calcasieu; but the product from the whole area might have its freight rates affected by rates on the Calcasieu should that stream be given 12 feet over the outer bar. I was informed that the capital of this company is largely from England, partly from Iowa. Much embarrassment in the effort to develop this vast tract is met by reason of the lack of water transportation. Thus the manager of the stock business estimates that 300,000 head of cattle and 750,000 tons of hay could be raised on the highlands. Both would be profitable products shipped by water to the West Indies and the Atlantic seaboard.

Present railroad rates make it almost impossible to develop either interest.

Depending upon the working of the agricultural lands are other projects contemplated by the company, such as meat and fruit canning factories.

Of the marsh lands 3,000 acres have been levied and thoroughly reclaimed, while 3,000 more are nearly reclaimed. It is estimated that all this sea-marsh land is of excellent quality for rice, sugar, or general vegetable culture, and will readily yield a product of $25 value per year per acre.

I believe it is the endeavor of the company to develop their lands by selling to settlers, but whether it will be this or a rent system I can not say with certainty.

Laying aside all question of public policy affected by such large ownership, it may be said that the large amount of capital involved in this tract, and the lumber lands also, is a guaranty of future development, should transportation facilities be improved either by public or private means.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieut. of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 12.

IMPROVEMENT OF BAYOU PIERRE, MISSISSIPPI.

The preliminary examination of this bayou was authorized by Congress and made in 1884. A full report of the examination was published in the Annual Report of the Chief of Engineers for 1885. Part of the bayou was deemed worthy of partial improvement by the removal of logs, snags, and overhanging trees, at an estimated cost of $20,000.

In August, 1886, Congress appropriated $5,000 for "improving Bayou Pierre, Mississippi, continuing improvement." With this money the snag-boat formerly in use on the Teche improvement, then no longer required for that work, was put in thorough repair, and in January, 1887, the plant was towed to the Bayou Pierre, Mississippi, and the work of cleaning out the bayou commenced and continued until the end of February, when high water backing up from the Mississippi prevented further work. During the short time engaged, 51 snags and 698 overhanging trees were removed from the bed and banks of the stream, and a reasonably good steamboat channel was obtained from the mouth upstream as far as the project called for.

In June, 1887, the water in the bayou having fallen sufficiently to enable work to be resumed to advantage, work was again undertaken, and in this month 84 snags, 35 sunken logs, and 30 overhanging trees were removed. A channel, such as was contemplated in the project made for the improvement of the bayou in 1884, has been completed at a cost of little less than $5,000. All the snags and overhanging trees that could interfere with navigation when there is navigable water in the bayou have been removed. When the snag-boat entered the bayou in January, 1887, she had to cut her way through the worst of the obstructions. At this time the water in the bayou was quite high, caused principally by backwater from the Mississippi.

Ordinary freshets occurred in the Bayou Pierre subsequently, and the currents loosened up much of the material heretofore forming the obstructions; and a channel having been opened, much of this material floated out into the Mississippi in the shape of drifts, so that after a channel had once been opened by our labor nature aided very much in doing the balance. The breaking through of these piles of drift also lowered the depth of water in the pools above and developed rock bottom in places where such was unexpected, near and above Widow's Creek, about 12 miles above the mouth, with such shoal water on this bottom as to make it difficult to haul the snag-boat over these localities, though drawing only 18 inches of water. Many of the larger loose rocks, some weighing over 2 tons, were broken up and removed from the channel. It was also found that when the bayou was high from backwater and with no perceptible current, a rise of 40 feet at the mouth only produced a rise of 13 feet at the railroad bridge, distant about 18 miles above the mouth. A reasonable inference to be deduced from this fact is that the surface slope of the bayou must be at least 27 feet and is probably much more. A single night's rain also raised the water in the bayou 10 feet in height and produced a current estimated at 7 miles per hour. This torrent carried such an immense volume of drift that no boat could have stood against it or remained in the bayou unless tied to the bank under the protection of the timber growing on its banks. In ten hours thereafter the bayou resumed its normal sluggish condition.

On June 27, 1887, I personally inspected the bayou. The Vicksburgh gauge indicated a reading of 22 feet, or 22 feet above low-water mark; at this stage of the Mississippi at Widow's Creek, on Bayou Pierre, the water was 10 feet deep, and 3 miles above Widow's Creek the depth of water was only 4 feet, while 5 miles above Widow's Creek there was not water enough for a skiff to float. This serves to indicate the rapid slope of the bottom of the bayou. One of the workmen engaged on the snag-boat, who is thoroughly familiar with the bayou, states that at the low-water stage of the Mississippi a skiff drawing 12 inches can not get into the bayou 1 mile above its mouth. There is no commerce whatever on the bayou, and during the greater part of the six months that our snag-boat has been in the bayou it was in a navigable stage for steam-boating; but in all this time only two skiffs and no other floating craft were seen.

As the work is now practically completed as far as the project called for, though at an expense far less than that estimated, it seems useless to spend any more money on this work. The snags and overhanging trees having been removed, there are now no longer serious obstructions to navigation in the bayou, excepting shoal water during low stages of the Mississippi; and to blast out rocks and to remove snags imbedded below the present bed of the bayou, and then dredge so as to increase the depth of water in the bayou, was never projected, and would cost far more than is commensurate with the benefits to be derived from such improvement. The improvement made will not be permanent, as the same kind of obstructions are likely to re-form at any time.

No further immediate appropriations are in my judgment required.

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,947.36
July 1, 1887, amount available	1,052.64

S 13.

IMPROVEMENT OF SABINE RIVER, LOUISIANA AND TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep.

In 1872-'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year. The estimated cost of improvement over this stretch of river by removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000. In June, 1878, Congress appropriated $10,000 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth. March 3, 1879, Congress appropriated $6,000 more and provided for a resurvey of the river from its mouth to East Hamilton. After the survey was completed it was deemed advisable to expend this money in improving the river above Orange, and cuts were made from the main river into the narrows and at Dead Bend; large numbers of sunken logs and snags were removed from the upper part of the narrows, enabling vessels of 5 feet draught to get 30 miles up river above Orange. In 1880 Congress appropriated $5,000 and in 1881 $7,000 more for this river. The bar at the mouth had again shoaled. This was redredged in 1881-'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length.

In 1882 Congress appropriated $4,000 more for this improvement. As the river is in a sufficiently good navigable condition for the limited commerce which it carries, this money has not been used, and it, together with a small balance left over from former appropriations, is yet available. No work has been done during the past year.

CONDITION OF THE WORK AT PRESENT.

The dredged channel has shoaled somewhat, and many saw logs have been lodged in it, but there is a deep enough channel for the very limited commerce using the river, and while the commerce is so small and not perceptibly increasing, it is deemed inadvisable to make any further improvement at present.

It is not evident that the improvements thus far made have been of much, if any, commercial advantage. When the channel was at its best freight rates were not reduced, nor did the commerce on the river perceptibly increase.

No appropriations for the fiscal year ending June 30, 1889, is asked.

Money statement.

July 1, 1886, amount available	$4,546.56
July 1, 1887, amount available	4,546.56

S 14.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873 and reserved from Bevilsport to its mouth. The following are the appropriations made for this river:

June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
August 2, 1882	5,000
July 5, 1884	7,000
Total	33,000

The project contemplated dredging a channel over the bar at the mouth of the river and the removal of obstructions from the river between Bevilsport and Yellow Bluff.

The bar at the mouth was dredged in 1880, and a channel 5 feet deep, 30 to 60 feet wide, was obtained.

In 1882 the obstructions between Yellow Bluff and Bevilsport were removed. The original estimated cost of making these improvements was, for work at the mouth of the river, $26,318.05, and for up-river, $15,000; a total of $41,318.05.

The amount thus far spent has been $21,332.16, leaving a balance available of $11,667.84, an amount probably sufficient to redredge a 5-foot channel over the bar at the mouth sufficiently wide for the purposes of navigation.

The bar at the mouth of the river has again shoaled, until, at extreme low water, there is a depth of about 3 feet over it. There is very little commerce passing in and out of the river, but as the bar at this place is the shoalest obstruction between the Gulf and Beaumont, Tex., and the money is available for dredging the bar, it is thought advisable to reopen this channel.

When reopened, while it will not be permanent, it is thought it may remain in fair navigable condition for several years. No appropriation is required for the fiscal year ending June 30, 1889. The only commerce on the river is carried by an average of two small schooners per week, and by one steam-boat, carrying brush for use in the construction of the Government works.

Money statement.

July 1, 1886, amount available	$11,667.84
July 1, 1887, amount available	11,667.84
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,667.84

S 15.

IMPROVEMENT OF SABINE PASS, TEXAS.

The object of the improvement is to obtain deep water over the bar at the entrance of the harbor. In 1878 and 1880 channels from 12 to 16 feet deep were dredged through the bar, but soon thereafter refilled. In 1882 a project and estimate for getting deep water were submitted. The plan was to build two jetties of brush and rock, each a little less than 4 miles in length, extending from shore across the bar out to deeper water in the Gulf, at an estimated cost of $3,177,606.50. Since this time Congress made the following appropriations for this work:

August, 1882	$150,000
July, 1884	200,000
August, 1886	198,750
Total	548,750

All the work done here thus far has been by contract after due advertisement. The work of jetty building began in 1883. With the first appropriation made, viz, $150,000, and about the same amount of unexpended balance left over from former appropriations, a contract was made and 188,552 cubic yards of jetty was built. The work was confined to the West Jetty. With the money appropriated in 1884 new contracts were made, work on the West Jetty was continued, and that on the East Jetty was commenced. In August, 1885, this contract was completed. Up to that time, August, 1885, the East Jetty was built up to the level of mean high water for a length of 10,840 feet, or a little over 2 miles in length. The West Jetty foundation was laid for a length of 16,074 feet, of which 7,270 feet was raised to the level of mean high tide.

The results produced by these only partially completed jetties in the fiscal year ending June 30, 1886, was to increase the depth of water on the bar to 8 feet in the shoalest places, where the original depth when work commenced was from 6 to 6½ feet, or an increase in depth of about

25 per cent; this means that the currents directed by the jetties scoured out a little more than 1,000,000 cubic yards of material from the bar.

In June, 1886, these jetties encountered a cyclone and worked an estimated damage, principally to the top work of jetties, of about $23,000.

In October, 1886, proposals were invited for continuing the work with the appropriation made in August of that year, and the following bids were received:

No.	Names of bidders and their residence.	Brush mattresses in place, per cubic yard.	For sandstone rock in place, per ton, 2,240 pounds.	For granite rock in place, per ton, 2,240 pounds.	For oyster shells in place, per ton, 2,240 pounds.
1	A. M. Shannon, Galveston, Tex	$1.75	$4.00	$4.80	$1.00
2	Peter Burke, Mobile; William Fagan, New Orleans, and Robert A. Wilson, New Orleans*	1.62½	4.00	4.80	1.75
3	Louisiana Jetty and Lightering Company, New Orleans	1.55	3.90	4.25	.50

* Bid incomplete.

Contract was awarded to Louisiana Jetty and Lightering Company for brush at $1.55 per cubic yard, and granite at $4.25 per ton (2,240 lbs.).

In this same month, during a violent gale in the Gulf, a tidal wave arose and inundated temporarily the entire country bordering Sabine Pass and Lake. The water is credibly reported to have reached a height of 8 feet above the ground on which the town of Sabine Pass stood. In less than an hour from the time this wave reached its height over 90 per cent. of the houses in Sabine Pass were either lifted off their foundation, thrown down, drifted away, or destroyed. One hundred and thirty lives were lost, and the few people spared were left destitute. The current is reported to have run with a surface velocity of over 20 miles per hour, and its direction was inward from the Gulf towards the lake. At all events, in a very short time, with the exception of five or six houses, Sabine Pass as a town was wiped out of existence. An examination of the jetties made a few weeks after the storm showed that the injury to jetties due to storm was slight.

Work on the new contract was resumed in January, 1887, most of the work being confined to the extension of the East Jetty and to building this jetty up to high-water mark throughout its length. During the past fiscal year the foundation of the East Jetty has been extended until its outer end is 14,000 feet from shore. This jetty, except here and there, where a little rock has yet to be thrown on to raise it to its full height, is completed up to the level of mean high tide for a distance of 13,312 feet from the shore end. About 9,100 linear feet of this jetty has been increased from 2 to 5 feet in height, to replace damage by storms and compression of brush due to weight of rock and action of the sea. It was noticed that numerous places in both jetties that had been built up to mean high-tide level in previous years had settled. Whether this was due to a bodily subsidence of the jetties, to compression of the brush, to a washing away of rock, to the effects of the teredo, or either of several of these causes combined, was not known.

In May, 1887, a careful examination by divers was made at several different points, especially in the West Jetty, which had been longest built, for a detailed report of which see Mr. Raymond's report herewith. Mr. Raymond's examination shows the foundation course of West Jetty to be intact for a distance of 9,000 feet from the shore end; from 9,000 feet to 11,000 feet from shore the injury to foundation course increases, and beyond 11,000 feet, viz, from 11,000 to 16,070, the foundation course is destroyed. On this foundation course a second tier of mats 6,146 feet long and 30 feet wide was built in 1883. This tier is very little injured, excepting the top fascines, which were not covered with rock. Of the third or top tier, built in 1885, which was 6,700 feet long and 15 feet wide, 3,000 feet remains; the other 3,700 feet were broken up or moved to the sea slope of the jetty in the storm of June, 1886.

The loss in height of jetty was traced and accounted for as follows: The foundation tier invariably settled into the mud equal to the depth of the lower fascines, viz, about 5 inches. The weight of rock ballast on top, together with pounding of sea, compressed and compacted the brush after each mattress was laid, sometimes 50 per cent. of its bulk as compared with its measurement when launched, and on the outer mile of foundation course the loss is due entirely to loss of brush owing to insufficient ballast and the teredo. When the jetties were sufficiently ballasted there was practically no loss of material; the destruction of the teredo was insignificant. The compression of the brush within the mattresses when first placed must and will continue.

Prior to the present year the brush in the mattresses was compressed by means of levers. The amount of compression possible by this means permitted the brush filling, of about 4 feet in height, to be compressed .7 of 1 foot. During the past year iron screws were used for compressing, and the result was that a 4-foot thickness of brush filling could be and was squeezed down .11 of a foot; in other words, a mattress 4 feet in height, exclusive of the grillages at top and bottom, was compressed till it only measured 2.9 feet in height, or fully one-half more than was possible without screws. Notwithstanding all this compression, when these mats are placed in the jetties the weight of rocks placed on top to secure them increases the compression so that a 4-foot thick mattress when finally in place and fully compressed measures only about 2 feet, or a trifle less, in vertical height.

The strangest feature developed by this examination was the perforation of the sand rock heretofore used as ballast. The rock, when removed from the jetty and examined, was found full of holes, many of them going through each piece of rock, the holes varying in diameter from ½ inch to less than 1 line. It is believed that these perforations are made by a marine animal, the nature or name of which to me is unknown.

There has been practically no commerce at Sabine Pass the past year. The large vessels which came there brought the rock from New York for building the jetties. A few little schooners passed in and out, carrying small loads, generally to and from Beaumont and Orange, Tex. No railroad trains have run to or from the Pass since the storm of last October, as about 10 miles of the road-bed was seriously damaged or destroyed, and this has not been repaired or replaced. About one month more of work on the jetties will complete the present contract. About $190,000 worth of work will then have been done in a little less than eight months on one jetty.

Twice this amount of work could have been done on this jetty, and the same amount on the other jetty, had the funds been available. The best results in the way of obtaining deep water by jetties can only be obtained by continuously rapid work on them. Large appropriations only can accomplish this. At the rate at which appropriations have been made for this work it will require sixteen years' additional time to complete the jetties as projected and approved, thus compelling a work to be twenty years in process of construction which should, if economic considerations are to govern, have been completed in about three years after the commencement.

One million of dollars is the amount of money that can be expended on this work in a fiscal year that will produce the best results. Whether or not there has been an increased depth of water on Sabine Pass Bar during the past five months is not definitely known. On the completion of the work this month a resurvey will be made, and the results of such survey will be forwarded as soon as known. Mr. Raymond's report, appended, gives a detailed report of work done during the year.

Money statement.

July 1, 1886, amount available		$2,646.36
Amount appropriated by act approved August 5, 1886		198,750.00
		201,396.36
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$117,934.22	
July 1, 1887, outstanding liabilities	42,380.91	
		160,315.13
July 1, 1887, amount available		41,081.23
Amount (estimated) required for completion of existing project		2,301,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

1.

REPORTS OF MR. THOMAS L. RAYMOND, ASSISTANT ENGINEER.

SABINE PASS, TEX., *June* 30, 1887.

SIR: I have the honor to make the following report upon the work of improving Sabine Pass Harbor, Texas, for the year ending June 30, 1887.

Work under the present contract was begun January 5, 1887, and has been carried on continuously since, except when a few days' delay has been caused by the failure of rock vessels to arrive. Construction has been confined to the east jetty, in raising its height along the whole length above mean low tide and extending it seaward across the present crest of the bar to deflect the current more in the direction of the jetty lines, a tendency to the eastward having been developed.

The foundation built in 1885 had been carried 11,170 feet from shore and has been extended to 14,000 feet.

The top course in 1885 was 10,890 feet long, and having been much injured by the storm of June, 1886, as detailed in the report of that date, 9,100 feet of this has been raised from 2 to 5 feet and the top course carried 2,422 feet farther seaward, or to a distance of 13,312 feet from shore. There has been used thus far under the present contract 49,654.2 cubic yards of brush and 18,025.5 tons of rock.

The following is a detailed statement of mattresses sunk this year:

Foundation mattresses, 27 feet wide, sunk in a double row between 11,170 and 14,000 feet from shore	56
Second-tier mattresses, 40 feet wide, 19 of which form the top course between 10,890 and 13,312 feet from shore	24
Third-tier mattresses, 30 feet wide, between 3,960 and 11,150 feet from shore	74
Third-tier mattresses, 24 feet wide, between 2,341 and 3,960 feet from shore	16

In addition to this the jetty has been raised by the following amount of rock alone to a height of 2 feet above mean low tide:

	Tons.
For a length of 300 feet, near 1,000 feet from shore	140
For a length of 250 feet, near 2,200 feet from shore	256
For a length of 500 feet, near 10,500 feet from shore	391

The following is a detailed statement of the width of various courses and present heights of this jetty, lengths being counted from the shore end.

0 to 1,300 feet single tier, 15 feet wide, 0.5 to 2 feet above mean low tide.

1,300 to 2,341 feet. Two tiers. Foundation, 30 feet wide; second tier, 15 feet wide; 1 foot to 2 feet above mean low tide.

2,341 to 3,700 feet. Three tiers. Foundation, 30 feet wide; second tier, 15 feet wide; third tier, 24 feet wide; average 2 feet above mean low tide.

3,700 to 10,890 feet. Three tiers. Foundation, 40 feet wide; second tier, 15 feet wide; third tier, 30 feet wide; 0.8 feet to 2 feet above mean low tide.

10,890 to 11,170 feet. Three tiers. Foundation, 40 feet wide; second tier, 40 feet wide; third tier, 30 feet wide; averages 2 feet above mean low tide.

11,170 to 13,312 feet. Two tiers. Foundation, 54 feet wide; second tier, 40 feet wide; 0.0 to 1.3 feet above mean low tide.

13,312 to 14,000 feet. Foundation, 54 feet wide; 4.5 feet below mean low tide.

The tracings submitted herewith exhibit this jetty in plan, profile, and cross-section, showing the amount of old and new rock.

WEST JETTY.

The report upon the diver's examination of this jetty having been submitted, detailing the causes and amounts of the deterioration, the following is a statement of the original dimensions of the work and present heights.

0 to 180 feet. One tier 15 feet wide; 1.8 feet above mean low tide.

180 to 1,050 feet. Two tiers. Foundation, 15 feet wide; second tier, 10 feet wide; averages 1.8 feet above mean low tide.

1,050 to 1,800 feet. Two tiers. Foundation, 30 feet and 45 feet wide; second tier, 10 feet wide; averages 1.6 feet above mean low tide.

1,800 to 2,100 feet. Three tiers. Foundation, 45 feet wide; second tier, 20 feet wide; third tier, 15 feet wide; averages 1 foot above mean low tide.

2,100 to 3,000 feet. Three tiers. Foundation, 60 feet wide; second tier, 30 feet wide; third tier, 15 feet wide; 0.5 feet above mean low tide.

3,000 to 5,570 feet. Foundation, 60 feet wide; second tier, 30 feet wide; third tier, 15 feet wide; averages 1.5 feet below mean low tide.

5,570 to 7,272 feet. Three tiers. Foundation, 45 feet wide; second tier, 20 feet wide; third tier, 15 feet wide for half the distance; from 1.5 to 2.5 feet below mean low tide.

7,272 to 8,700 feet. One tier. Foundation, 45 feet wide; averages 3.5 feet below mean low tide.

8,700 to 10,000 feet. One tier. Foundation, 60 feet wide; 3.5 to 6.0 feet below mean low tide.

10,000 to 14,000 feet. One tier. Foundation, 60 feet wide; nearly all destroyed.

14,000 to 16,070 feet. One tier. Foundation, 75 feet wide; all destroyed.

The accompanying tracings show the present condition of this jetty better than is possible by more detailed statements in figures.

The deterioration of this jetty shows the necessity of completing in the most substantial manner such portions of the work as the limited appropriations will permit, regardless of the injurious effect of the scour beyond upon the future work in greatly increasing its cost, as past experience teaches that the time and means of doing future work are very uncertain. No general survey to ascertain depths has been made since January last, as other duties have been pressing, and it is expected that one will be made upon the completion of the present contract now close at hand.

During the past six months, however, several vessels drawing from 10 to 12 feet have been towed across the bar. While this does not represent actual depths, it shows that the soft bottom presents no great obstacle to vessels with steam entering the harbor drawing 12 feet.

Very respectfully,

THOS. L. RAYMOND,
Assistant Engineer.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

2.

SABINE PASS, TEX., *May* 28, 1887.

SIR: I have the honor to submit the following report upon the examination of the west jetty at Sabine Pass, Tex., by diver to discover the amounts and causes of loss in height since the construction.

The examination was begun May 5, as soon after the receipt of your letter directing the same as preparations could be made, and concluded May 24. The general method of procedure was to anchor the boat containing the diving apparatus at the point selected and obtain a careful cross-section of the jetty there. The exact spot to be examined was then located and a number of soundings taken around it. The diver now removed all the rock from a space of about a square yard, passing most of it aboard for examination. When the brush was then exposed, soundings were taken upon it and its removal begun; cutting tools, hooks, and tackle were used in breaking out the brush, and a force-pump for washing out sand as it accumulated in the hole. The diver examined in this way the condition of the work at six different points, selected so as to include the various degrees of loss, and probings were made at four other points.

The portion of the west jetty built in 1883 consisted of 16,070 feet of a single foundation course, and 6,146 feet of a second tier built upon the shore end of this foundation. In 1885 a third tier was built 15 feet wide to a distance of 7,270 feet from shore. Briefly stated, the condition of the jetty is as follows: The foundation course from shore seaward, a distance of 9,000 feet, is in good condition, having suffered no loss of material. In the next 2,000 feet the amount of material lost gradually increased until at 11,000 feet from shore, and beyond to the end of the work the whole of the single course has been destroyed. Of the second tier, 30 feet wide, built in 1883, the whole remains uninjured, except two top fascines, which were never covered with ballast. Of 6,700 feet of the top tier, 15 feet wide, built in 1885, 3,000 feet remain, the balance having been broken up or moved to the sea slope of the jetty in the storm of June, 1886.

In the diver's examination of the jetty, points were selected for boring, which illustrated the various conditions of the work, viz.: 4,500, 7,480, 9,490, 10,200, 10,950, 11,000 11,800, 14,200, and 16,000 feet, respectively, from the shore end of the jetty.

EXAMINATION NO. 1.

Four thousand five hundred feet from shore. Two courses, built in April and October, 1883, and 60 feet and 30 feet wide, respectively. One top course, 15 feet wide, built July, 1885.

	Pounds.
Weight to square yard on foundation	270
Weight to square yard on second tier	320
Weight to square yard on third tier	440

Third tier broken up in storm of June, 1886. Foundation and second tier in good condition; no brush washed out. Rock of second course somewhat perforated by worms; oysters and barnacles abundant; brush sound and strong; only loose ends of top course wormed; body of mat filled with sand and shell; removed with difficulty by pump.

Soundings.

	Elevation.		Difference.
	1883.	1887.	
Top of rock	+1.3	1.7	3.0
Top of brush, second tier	0.4	2.6	2.2
Top of brush, foundation	3.3	5.1	1.8
Bottom of brush	6.4	6.8	0.4
Original bottom and pass	6.8	6.8	0.0

Showing a total loss in work of 1883 of 3 feet, distributed as follows:

	Feet.
Settlement in bottom of bottom fascines	0.4
Compression of brush in mattresses	2.6

EXAMINATION NO. 2.

Seven thousand four hundred and eighty feet from shore. Orignally one course, 45 feet wide, built in May, 1883. Weight of ballast per square yard, 360 pounds. A considerable part of the rock showed signs of perforation; oysters abundant; brush strong and sound, with bark and leaves; slightly wormed where ends protruded; all original courses of brush found; body of mattress filled with sand and mud; top fascines missing, not originally covered with ballast.

Soundings.

	Elevation.		Difference.
	1883.	1887.	
Top of rock	0.8	3.6	2.8
Top of brush	1.6	4.4	2.8
Bottom of brush	5.6	6.3	0.7
Bottom of fascines	6.0	6.7	0.7
Bottom of pass	6.0	6.3	0.3

Showing a total depression of 2.8 feet, distributed as follows:

	Feet.
Compression of brush filling	2.1
Bodily settlement of filling	0.3
Settlement of bottom fascines	0.4

At this station, as at the first, the ballast was found well distributed and the brush very compact.

EXAMINATION NO. 3.

Nine thousand four hundred and ninety feet from shore. This station shows the beginning of the loss of material, there having been originally built here a foundation course 60 feet wide in 1883, consisting of two 30-foot mattresses sunk side by side. Weight of ballast per square yard, 240 pounds. The mattress east of the axis of the jetty was found in good condition except near the inner edge, and the examination was made at this part of the mattress to determine the cause of its failure. The stone was found much perforated, especially the smaller and softer pieces; the rock was found well distributed over the uninjured part of the mattress, but only a small amount when the boring was made could be discovered. The brush was found wormed at the ends where the mattress was broken up. Three of the five original courses of brush in the mattress remained.

Soundings.

	Elevation.		Difference.
	1883.	1887.	
Top of rock	2.3	5.1	2.8
Top of brush	3.0	5.6	2.6
Bottom of brush	6.1	6.8	0.7
Bottom of fascines	6.5	7.2	0.7

Showing a total loss of 2.8 feet in height, distributed as follows:

	Feet.
Loss of material and compression	2.0
Bodily settlement of brush	0.3
Settlement of lower fascines	0.4

The western mattress at the same place was found to be completely broken up, only scattered portions of it remaining lying loose upon the bottom. The rock showed the usual amount of perforation, while the brush was all wormed throughout, though not broken or crushed.

EXAMINATION NO. 4.

Ten thousand two hundred feet from shore. Originally one course, 60 feet wide, sunken in 1883. Weight of ballast to square yard, 240 pounds. Here the mattresses were found completely destroyed and only scattered rock was encountered, buried 1 foot beneath the sand bottom. Below the rock soft mud was met by the probing tool.

EXAMINATION NO. 5.

Ten thousand nine hundred and fifty feet from shore. Originally one course, 60 feet wide, loaded with ballast, 250 pounds to the square yard, built in 1883. No brush found by the prod, which was with difficulty forced through 14 inches of sand and the stone beneath. Where the joint of the mattresses had been, the prod was easily forced into the mud bottom.

EXAMINATION NO. 6.

Eleven thousand feet from shore. Originally as at No. 5. Diver found small quantities of brush and stone near top of sand-drift. Brush all wormed and rock perforated. One piece of cane was found, which could only have been a part of the bottom fascine.

EXAMINATION NO. 7.

Eleven thousand eight hundred feet from shore. Originally one course 60 feet wide, weight of ballast 240 pounds to square yard. Eastern side of axis covered with sand to a depth of 14 inches, at which depth the diver, with difficulty, was able to prod through the underlying rock, but could detect no brush. The western side, somewhat deeper, was free from sand, and considerable brush and rock was found scattered about the bottom. Large hard rock, not perforated, covered with oysters and beginning of coral formation, softer rock all perforated, brush all wormed, but still strong and full size. Beyond this to the end of the foundation laid in 1883, prodding showed but a repetition of this last case. It seems evident from the above that the chief and probably only material causes of loss in this work are compression and destruction of mattresses insufficiently loaded. Measurement of mattresses sunk under the present contract with weights varying from 740 to 1,000 pounds per square yard indicate an average loss of 31 per cent. by compression. The weight is much greater than any used in 1883, but the solidity of mattresses now is much greater before launching than in 1883, the compression being obtained under present plans by screws. The examination show no settlement of moment into the bottom. The teredo has in no instance attacked the brush where it has been well held together in compact masses, and no loss of material has occurred except where the brush was exposed, by imperfect loading, to the action of the waves and current. All the foundation course lost was sunk in from 6¼ to 15¼ feet depths, and it is difficult to distribute ballast equally over submerged work. The destruction of parts of a mattress displace the ballast from the remainder until the whole is lost. Where the work has been brought near the surface, permitting the proper distribution of ballast, it has remained uninjured, except in the case of the 15-feet wide top mats, built in 1885, which were too narrow to provide for a slope to the edges, and could not be protected by riprap on account of scarcity of ballast, and were destroyed by the exposure of a perpendicular face of brush to the sea in the storm of June, 1886.

The remedies for these defects are evident, and have anticipated this investigation by their adoption under the present contract: (1) The amount of compression under ballast is being reduced as much as possible by obtaining a greater amount in the measured mattresses; (2) the work is being raised to high tide as far as carried, insuring proper loading and cutting off cross-currents, thus inducing deposits in and behind the work; (3) the amount of ballast per yard has been increased to permit the covering of all the brush; (4) granite instead of sandstone is now in use, gaining durability and weight under water.

Very respectfully,

THOS. L. RAYMOND,
Assistant Engineer.

Maj. W. H. HEUER,
Corps of Engineers.

S 16.

REMOVAL OF SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of the wreck of steam-boat Maria A. from Bayou Teche near Charenton, Louisiana.—In accordance with law and instructions from the War Department, notice by advertisement was given to all persons interested in the wreck of the steam-boat *Maria A.* to have the same removed. The legal time of notice expired on April 4, and no action being taken, authority was asked to have the wreck removed, the work to be done by contract. Authority being granted, proposals were invited by advertisement and opened on May 31, 1887. The following is an abstract of proposals received:

No.	Name and address of bidder.	Amount.
1	John H. Gardner, New Orleans, La	$669
2	Peter Usner, New Orleans, La	875
3	John J. Atkinson, Houston, Tex	575
4	James L. Bunis, New Orleans, La	1,850
5	Samuel W. Skinner, Wilmington, N. C	1,800
6	Wm. H. Brown, New Orleans, La	475
7	Harry Freeman, Franklin, La	450
8	Lewis Augers, New Iberia, La	350
9	Wm. L. Campbell, Mobile, Ala	1,425
10	Wm. Evans, New Orleans, La	600
11	Victor Von Schorer, Franklin, La	500

The contract was awarded to Mr. Lewis Augers, of New Iberia, La., he being the lowest bidder, in the sum of $350.

On June 15 I made a personal examination of the locality and found that the wreck had been raised entire and towed to New Iberia, La., where it now lies. Advertisements are now out for the sale of this wreck at public auction on July 15, 1887.

S 17.

PRELIMINARY EXAMINATION OF BAYOU ROUGE, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 23, 1886.

GENERAL: I forward herewith a report of Lieut. O. T. Crosby, Corps of Engineers, on an examination of the Bayou Rouge, Louisiana, made recently as required by act of Congress of August 5, 1886. For the reasons given by Lieutenant Crosby, in which I fully concur, this bayou is not worthy of improvement.

Very respectfully,

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 22, 1886.

SIR: I have the honor to report as follows upon an examination of Bayou Rouge, Louisiana, recently made under orders from you. This preliminary examination was provided for by act of Congress approved August 5, 1886.

Bayou Rouge has its source in Lake of Pearls, a shallow body of water about 6 square miles in area, lying south of Red River, and receiving its principal supply from bayous sent off from Red River. Its principal outlet is a small stream about 2 miles long, which separates into two streams; one, the Bayou De Glaise, flowing directly to the southeast and, after a tortuous course, reaching the Atchafalaya near the head of that river; the other, Bayou Rouge, flowing northwest, then southeast until it too, after a tortuous course, reaches the Atchafalaya about 30 miles below the mouth of the De Glaise. Bayou Rouge is about 55 miles long; for present consideration it may be divided into four sections.

The first section is 10 miles long, and extends from the point of separation of the two bayous (commonly known as the Junction), to a landing known as Enterprise. This point is reached by boats at every high water, the route being from the Atchafalaya along Bayou De Glaise. There is practically no water here during the fall and early winter season, so that at the time of my examination, November 19, there was not sufficient water to float a skiff, and the work of examination was done in buggy and on horseback. This state of affairs continues until the general rise of the Mississippi and Atchafalaya, the navigation season extending generally from February to May.

There are in this section several sharp bends, but as the cross section is quite flat, the small boats plying on this stream are able at high stages to make the points without difficulty. Indeed, I could not learn, from people living in the neighborhood, of any serious complaint made by the steamboat owner during his season of activity. There are, here and there, willow trees which brush against the upper works, but, being very pliable, I was told that they offer only an inconsiderable obstruction.

Since the bayou is unnavigable at low water, the logs and stumps, now and then seen on the bottom, are not obstructions.

The second section extends from Enterprise Landing to Evergreen, and is 6 miles long. Evergreen is a small town, having three or four stores, and selling about $145,000 worth of goods per annum. The distance by land from Evergreen to Enterprise is 2 miles, the bayou making long bends between the two places. The boating business of Evergreen is done at Enterprise Landing. While it is possible for the boats running on the bayou to go beyond Enterprise, they do not do so because of the sharp bends in the section considered, because there are trees obstructing the passage, and because there is little to be gained, the road to Evergreen being short and good. Indeed, it would be impossible to go beyond the edge of the village, as there is a fixed bridge over the bayou, recently erected. Moreover, the cross section changes in character a short distance below Evergreen, the banks becoming very steep, the bayou very narrow, so that it would be extremely difficult for any but the smallest craft to make the bends. For these reasons there have been no boats at Evergreen since 1874, when, the whole country being flooded, one boat made its way to the village.

The third section extends from Evergreen to Big Cane, distant by road about 13 miles, by bayou about 15 miles. This section is considered by all as entirely unnavigable. Many persons with whom I conversed on the subject supposed that the clause requiring this examination could not have been intended by its framer to apply to any part of Bayou Rouge below Evergreen. But since no limitation was expressed, I report on the whole. The banks in this—the third section—are steep, the bayou very narrow, the bends very short, the trees growing between the banks very numerous.

At the time of the examination it could not be navigated in a pirogue; in the season of flood it is filled with a rapidly flowing mass of water. In neither condition is it navigable.

The fourth section extends from Big Cane to the Atchafalaya. For many years previous to 1882 this section was rendered navigable during the greater portion of the year by a dike built across its mouth, separating it from the Atchafalaya, and as the waters fell in summer, sufficient supply was retained to considerably prolong the season of navigation for the small boats usually plying in the trade; in times of flood the dike served as a protection to a considerable area of land.

This dike was destroyed in 1882, since which time the navigable season has been on this section what it is on Bayou Rouge and De Glaise generally—about three months per year. It is confidently stated by reliable parties at Big Cane that the State of Louisiana will certainly rebuild the dike. Since its destruction there has been practically no navigation, even at high water, on this fourth section.

The Texas and Pacific Railroad began in 1882 to take freight from Bayou Rouge. There are two stations, each only 5 miles distant from Big Cane, and other stations equally near to points lower down the bayou. The railroad rates on cotton—$1.75 per bale—are the same as the boat rates when they handled freight across the dike. There are no obstructions preventing the easy ascent of boats, at high water, to the point hitherto reached by them. Should the dike be rebuilt, low-water navigation may be resumed as it was before. The transportation facilities now offered by the railroad would probably discourage such an endeavor, especially when it is considered that the total amount of cotton to be handled in this vicinity, as reported to me by the principal planter and merchant at Big Cane, is about 3,500 bales.

The third section having long been recognized as unnavigable, a fixed bridge has been built across the bayou at Big Cane.

From the foregoing description of Bayou Rouge, it will be seen that the first section, 10 miles long, and the fourth section, 24 miles long, have good high-water navigation and no low-water navigation; that the second section, 6 miles long, could be given high-water navigation (cutting heavy trees and diminishing sharpness of bends), but that little would be gained thereby, while the cost would be considerable; that the third section is not susceptible of improvement within any reasonable financial limits.

If high water occurred early enough to move anything but a small fraction of the crop, it might be well to remove the few obstructions, such as willow trees, in the first section, but since these are not seriously in the way, and since most of the crop has been moved by the time boats commence to run, no expenditure here could be recommended.

The matter of obtaining all-the-year navigation for bayous De Glaise and Rouge has frequently been discussed by those interested. This can be done only by a system of canalization, wholesale dredging to navigable depth below low water of the Atchafalaya being out of the question on account of cost.

The only reservoir from which water for canalization could be obtained is Lake of Pearls, above referred to. The idea heretofore entertained has been that of placing a lock at the mouth of Bayou De Glaise, a dam at some point on the Rouge near Evergreen, and as many locks intermediate between these structures as would break up the stretch of about 60 miles into convenient pools; the canal thus formed to be filled by draining Lake of Pearls into it.

The efficacy of this plan depends upon two conditions—the sufficiency of supply from the lake, and the sufficiency of its elevation over the bayou bottom in order to give navigable depth. To learn what I could without instruments concerning these points, I penetrated the cypress swamp surrounding the lake, and, by the aid of water-marks, found that the low-water surface of the lake is about 12 feet below the high water of 1882. At a point about 10 miles below Evergreen, 6 miles above the Junction, the bed of the bayou was found, by aid of similar marks, to be about 12 feet below the same flood, showing that the lake level, extended into Bayou Rouge, would give less than 6 miles of navigable water.

This rough measurement, checked by data kindly furnished by the Louisiana State engineer office, I find to be correct to within an inconsiderable error.

Even if the whole distance from the Junction to Evergreen could be improved in the way considered, the cost of the work, compared with the business on *Bayou Rouge alone*, would be extravagant.

What the conclusion on this head might be were the interests of Bayou De Glaise also considered I do not know. It is certain that to improve even 3 or 4 miles of Bayou Rouge costly works must be built in the De Glaise, the commerce of which is far greater than that of the portion of Bayou Rouge to be benefited. But whether one or both bayous be considered, no costly work could be recommended until something is known concerning the treatment to be given the Atchafalaya and its connection with the Mississippi. No improvement would be of value unless it could give a cheap route to New Orleans, the general market.

The commerce on Bayou Rouge is almost wholly in cotton. Last year about 3,800 bales were raised between the Junction and a point below Evergreen, beyond which cotton usually goes to Big Cane or the railroad stations near it. All the cotton shipped from Evergreen and its vicinity goes to the railroad, unless the water rises very early, in which case a part of the crop goes by the small boats running to Enterprise Landing from the Atchafalaya River. The sugar-mills in the vicinity of Evergreen produce about 1,500 hogsheads of sugar and 2,000 barrels of molasses. As has been stated, about 3,500 bales of cotton are raised on the lower bayou. The average haul for the 3,800 bales raised on the upper bayou is about 9 miles to Irion, the railroad shipping station. The sugar-mills are nearer the railroad; their average haul would be perhaps 4 miles. The average haul for cotton costs about 50 cents per bale; railroad charges, $1.75. The average haul on the lower bayou is less than the upper. The only improvement that could be applied to this part is already contemplated by the State on the ground, however, of protection from overflow, improvement of navigation being incidental and of small value. The lands along the bayou are now quite thickly settled; prospective commerce can not be predicted as much larger or smaller than that now existing.

Since high-water navigation, where at all practicable, is now but little obstructed; since when it exists it can handle but a small part of the business; since low-water navigation can be obtained only at immense cost (extensive dredging, removal of thousands of trees, erection of locks and dams, etc.), Bayou Rouge is not, in my opinion, worthy of improvement in the sense in which I understand those words to have been used by Congress.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 18.

PRELIMINARY EXAMINATION OF BAYOU TERRE BONNE, LOUISIANA, FROM HOUMA TO THIBODEAUX.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 9, 1886.

GENERAL: I forward herewith a report of First Lieut. Oscar T. Crosby, Corps of Engineers, being the result of an examination of the Bayou Terre Bonne between Houma and Thibodeaux, La., as called for by the river and harbor act of August 5, 1886.

Lieutenant Crosby's report shows that the greater portion of the bayou above Houma is a bayou only in name, parts of it being dry and other parts being only a drainage ditch. Under these circumstances the part examined is certainly not a navigable stream. It can only be made navigable by making a canal in what was once the bed of the bayou, now practically dry.

I concur fully with Lieutenant Crosby, for reasons which he gives, that the bayou between Houma and Thibodeaux is *not* worthy of public improvement.

Very respectfully,

W. H. HEUER,
Major of Engineers.

THE CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 8, 1886.

SIR: I have the honor to report as follows upon a preliminary examination of Bayou Terre Bonne from Houma to Thibodeaux, La., recently made by me under your orders.

The distance from Houma to Thibodeaux is about 16 miles. Thibodeaux is the point at which Bayou Terre Bonne, in years past, drew its water supply from Bayou La Fourche, and thus indirectly from the Mississippi. This connection has long since ceased to exist.

Houma is situated at the head of navigation on Bayou Terre Bonne, which continues its course to the Gulf, connecting laterally with other streams and lakes, by partly artificial, partly natural water-ways, until the Mississippi is reached opposite New Orleans. The boats running on this lower part of Bayou Terre Bonne are small and are, at times, at this season, prevented from running during several weeks by lack of water. These difficulties of navigation are being overcome by dredging, the work under the last Congressional appropriation having reached a point about 10 miles below Houma, with money enough still available to continue dredging a channel 35 feet wide by 5 feet deep (below Gulf level) to within 3 or 4 miles of Houma, perhaps closer. It is hoped that completion of the improvement to Houma, by affording uninterrupted navigation, may result in a reduction of rates, through competition between water and rail.

At Houma the stream is now about 2.5 feet deep and perhaps 40 feet wide, though the cross-section being very flat much the greater part of this width is covered by water only a few inches deep. The fact that a tow-boat of about 14 feet beam and 18 inches draught can not run, sufficiently shows the condition of the stream. The bed of the stream is overgrown with marsh and water grass.

For a distance of 3 miles above Houma there is practically no change; the width varies somewhat, the depth correspondingly, the cross-section remaining about the same. At this point, 3 miles above Houma, the Terre Bonne is fed by Bayou Cane, a short stream about 15 feet wide and 500 or 600 yards long leading out from a great swamp reservoir. It is called sometimes a lake, sometimes a prairie or floating prairie. It is a basin receiving the drainage from the country between Bayous Black and Terre Bonne. It is at times covered by a heavy growth of water grass; hence the name of floating prairie. There is at all seasons, even now after a long drouth, some outflow. It is this outflow that supplies the small volume now flowing through Bayou Terre Bonne.

Beyond Bayou Cane the Terre Bonne is practically dry. Since its bottom lies several feet below the roads along its bank, there is, of course, a little seepage water here and there, sometimes in holes 2 or 3 feet deep. A few miles above the Cane the course of the bayou is traced by the shallow depression of its former bed and the line of rushes which conceals whatever water may lie under them. In many places the bed is perfectly dry. As Thibodeaux is approached the bed is found to be continually dry, so that even the rushes can not grow. Here ditches have been dug in the former bed to assist in draining the road, and finally the "bayou" becomes simply a part of the system of drainage ditches of the town of Thibodeaux.

It will be seen from this description, which is that of its ordinary state, that the term *Bayou* Terre Bonne is tractional, rather than veritable. During seasons of heavy rain there is, of course, some water in the old bed, but no boat can go further up than Bayou Cane. The owner of the *Harvy*, one of the tow-boats now tied up at Houma, informed me that he sometimes ascended to the Cane in order to open the water-grass, thus permitting a freer flow of the prairie water into the Terre Bonne. He said that to go beyond that point would require not the improvement of an existing water-way, but the construction of a canal. Such, indeed, is the fact. That such a work would be of some benefit can not be doubted, as water-routes throughout an agricultural country are always desirable; that its construction, considered from the engineer's point of view, is feasible—even easy—can not be doubted; but it is equally evident that the work can not be recommended as the improvement of a water-way. To create one, taking advantage of the depression in the general surface, caused by previous flow of a considerable body of water through what was an outlet of the Mississippi, would involve the cutting of a channel to be filled by tide-water, aided somewhat by drainage from a small area. Such a cut would involve the removal of about 850,000 cubic yards of earth, the depth being 5 feet, the width 30 feet. The dredge below Houma is removing earth at a cost of about 4 cents per cubic yard, counting running expenses alone. It would probably be safe to estimate 10 cents as the cost, including plant, superintendence, etc., or about $85,000 for a tidal canal to Thibodeaux.

As the road which follows the bayou bed is at many points quite near the line that would mark one side of the cut, there might arise embarrassing—perhaps costly—considerations as to injury done this road. Of this, however, nothing certain can be said. At Terre Bonne, or, as it is now called, Schriever's Station, it would be necessary to have a draw-bridge constructed in the line of the Southern Pacific Railroad. As the stream was not navigable when this road was constructed, it is probable that the owners could demand compensation. On account of these and other contingencies, impossible to foresee, it would be prudent to place the final cost at not less than $100,000.

The strip of cultivable land between the bayou and the swamp, lying on either side, will average not more than half a mile in width, or a total of 16 square miles. About half of this is now under cultivation, while the other half has been abandoned. Some small corn and rice farms are beginning to appear on the abandoned sugar plantations. A branch road leaves the main line of the Southern Pacific at Schriever's Station for Houma to the south, and another for Thibodeaux to the north, both branches lying not far from the proposed cut.

Supposing the work completed to Thibodeaux, together with the work now progressing toward Houma on the lower bayou, the resulting benefits would be, better drainage for the lands lying along the new water-way; navigation for small boats from Thibodeaux to the Gulf. This route could scarcely be followed outside, as the small boats fitted for the canal would not be fitted for the Gulf voyage to the mouth of the Mississippi. They would go either to Thibodeoux, delivering there across the Bayou La Fourche Levee to boats running to New Orleans, or to the railroad; or they would go south, then east by the small canals, bayous, and lakes constituting the present Lugger Route. In either case active competition with the railroad would be difficult, perhaps impossible. The canal would probably serve as an excellent local highway, and would be much appreciated for its aid as a drainage stream.

Perhaps it was necessary that this report should go no further than to show that the proposed work could not properly be recommended as the improvement of an existing water-way, but knowing, as I well do, the great importance of improved transportation routes to the rich agricultural country through which the examination took me, I have gone further to show what would result from constructing a water-way along the line considered.

Viewing it in this light, I can not refrain from drawing attention to the fact that in this case, as in others in the same section, recommendations would almost certainly be reversed could the works be considered, not separately and as unconnected, but as parts of a system of short-line water communication through southern Louisiana to New Orleans.

Considered separately, improvements such as that under discussion appear as local highways, lessening the use of wagon transportation to railroad stations. Considered as parts of a whole, they appear as water-routes permitting actual competition for products of great value with the railroad, which now practically controls the business of this rich section. Thus the value of any improvement in the Terre Bonne section is immensely increased. Its character becomes much more national if it be connected with Bayou La Fourche, and at the same time it be known that that important stream is to receive some definite treatment.

In conclusion, the work is not, in my opinion, a public necessity, its local character appearing plainly from what precedes; and "Bayou Terre Bonne from Houma to Thibodeaux" is not worthy of improvement in the sense in which those words have been used in river and harbor acts.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 19.

PRELIMINARY EXAMINATION OF BAYOU VERMILLION, LOUISIANA, TO SECURE NAVIGATION FROM ABBEVILLE TO THE RAILROAD BRIDGE OF THE LOUISIANA AND TEXAS RAILROAD.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 17, 1886.

GENERAL: I forward herewith a detailed report by Lieut. O. T. Crosby, U. S. Engineers, of his examination of the Bayou Vermillion, Louisiana, from Abbeville, La., to the crossing of the Louisiana and Texas Railroad Bridge, made in accordance with act of Congress approved August 5, 1886. To improve the stream for navigation between the points named is estimated to cost $5,000.

Between the points examined is a wooden wagon bridge, without a draw, through which steam-boats can-not pass. Were the other obstacles to navigation removed this bridge would still be an obstacle to navigation, and were this removed, or provided with a draw, the stream would then simply permit water transportation to the railroad bridge, where there is no depot, and which is about 1½ miles from the nearest freight depot, instead of by wagon haul of about 6 miles as now.

The improvement, if made, would be purely local and not permanent. For the reasons expressed in Lieutenant Crosby's report, and considering the present demands of commerce, this bayou is, in my opinion, not worthy of improvement.

Very respectfully,

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT OSCAR T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 15, 1886.

SIR: I have the honor to submit the following report on a preliminary examination of Bayou Vermillion to secure navigation from Abbeville to the Louisiana and Texas Railroad Bridge, Louisiana, recently made under your orders. Almost the whole of the portion of Bayou Vermillion to be considered, namely, 22 miles from the railroad bridge down toward Abbeville, was improved in 1881.

In 1882 the remaining distance, about 3 miles, together with all that part south of Abbeville, was improved, and a dam shutting off a cove near the mouth of the bayou was built with the hope of deepening the water over the bar in Vermillion Bay. The work was done by contract, and, so far as I can learn, not well done. The present condition of this stream will be better understood by considering it in three sections.

Starting from Abbeville, the first of these extends about 15 miles up-stream. This portion is now navigable for steamers of considerable size. The *Barmore*, about 140 feet long by 30 feet beam, drawing about 3 feet, makes regular weekly trips from Morgan City to the upper end of the section considered. She runs under contract with the Southern Pacific Railroad, her charges being fixed at 70 cents per barrel, $1.65 per bale of cotton, $3.30 per hogshead of sugar; her trip, under the contract, can not extend up nearer than 6 miles to the depot at La Fayette. This depot is about 1¼ miles from the crossing of the bayou and railroad at Morgan City.

The *Barmore* delivers freight to the railroad, reserving a fixed portion of the whole freight. The business is scarcely sufficient to pay for running the boat, and her captain is now trying to obtain new and higher figures in his contract with the railroad.

The larger part of her business is found below Abbeville. She runs with little difficulty to the point indicated, say 15 miles above Abbeville—that is, with little difficulty so far as the river proper is concerned. The bar at its mouth offers a serious obstruction.

While examining the bayou in a skiff, the water being at a low stage, I counted in the stream about 25 obstructions, snags and logs; overhanging the stream about 30 trees, whose removal would be beneficial. None of these obstructions are serious.

The second section extends from the upper limit of the first to Pinhook Bridge, about 2 miles by bayou from the railroad bridge, and about 2 miles by dirt road to the Lafayette depot. Ascending this section obstructions were found to be more and more numerous, until at a point about 3 miles below Pinhook Bridge, the skiff could go no farther, being stopped by great trees lying across the bayou from bank to bank.

Up to this point I counted about 80 obstructions in the bed and the same number of overhanging trees. Many of these are serious obstructions whose removal would be necessary in order that the stream might be navigable. At two points the skiff had to be poled over short bars, and in the last quarter of a mile it was passed over trees lying in the bed, only with great difficulty. This section, from the 15th to the 23d mile, counting upward, is now navigated for 2 or 3 miles by the *Josephine Spengler*, about 100 feet long by 25 feet beam, running in connection with the *Barmore*, while the buiness of the harvesting season justifies it. Above the limit of her trip, a very small tug-boat, drawing barges, runs at irregular intervals.

Three or four years ago a steam-boat, of nearly the same dimensions as the *Spengler*, ran over the whole of this section, delivering goods at Pinhook Bridge, then running out of the Vermillion along the Gulf coast to the Atchafalaya, thence to the head of the Atchafalaya, then down the Mississippi to New Orleans.

This trip, something like 550 miles in length, was made in opposition to the railroad, the distance from Lafayette to New Orleans being 144 miles. The steam-boat, working at such disadvantage, could not maintain its cause. Since it stopped running the section considered has become obstructed until even a skiff can not pass. Even were the obstructions removed, the width and depth are such that only small boats could pass at low water.

As it was impossible, for reasons stated, to make a close count of the obstructions in the last 3 miles of this section I estimate them on the basis of the number passed in the last quarter of a mile, when the skiff was hanging on some obstructions every minute or two. The numbers for the whole section, obtained in this way, are, in the stream, 350; overhanging, 250. The shoals that were met seemed to be caused by the logs lying in the bed, and would doubtless deepen were these logs removed. Mr. Wise, who ran the opposition boat referred to, is confident that the logs cause the small bars. In any case, they were not serious obstructions, as they were very short and of soft material, such that a small boat fitted for this part of the bayou could urge a passage over them. It is also to be remarked that the water was unusually low at the time of my examination, thus causing the bars to appear at their worst.

The third section, from Pinhook Bridge to the railroad bridge, is in about the same, or even worse, condition than the worst part of the second section. The number of obstructions in the channel I would estimate at about 250; overhanging trees, 175. Before the construction of the railroad this section was navigated by small boats, the Pinhook Bridge then having a draw. It is now a fixed bridge, and for many years has been the upper terminus of the most venturesome navigation on the Vermillion.

A few years ago the railroad company, at the request of the people of this vicinity, built a depot at the railroad bridge across the Vermillion. It was hoped at the time that the bayou would be sufficiently cleared of obstructions, and Pinhook Bridge so arranged with a draw as to permit boats to reach the railroad and deliver their freight directly, thus avoiding the 2-mile haul to Lafayette. Neither of these hopes was realized, the depot was not used, and navigation, even up to Pinhook Bridge, ceased.

I have seen Mr. Hutchinson, general manager of the railroad, to learn whether or not the depot would be re-established should the bayou be opened up to the railroad bridge. On this point he will say no more than that if business justifies such expenditure, the company will establish the depot. As the water route, even for points 20 miles distant from Lafayette, is in no sense a competitor with the railroad, it is evident that the value of any improvement of this section between Pinhook and the railroad bridge depends wholly on the existence of a depot at the latter bridge. The movement of freight would be *toward a depot;* if the depot at Lafayette were the only one to be reached, boats would stop at Pinhook Bridge and deliver to wagons which would haul to that depot, 2 miles or more distant, along the established road; they would not go to the railroad bridge, which is not connected with the depot by a good road.

Recapitulating, it appears that to clear the bayou up to Pinhook Bridge will require the removal of about 400 obstructions from the channel and about 300 overhanging trees. Their removal would cost, judging from cost of similar work in other streams, and allowing for contingencies, about $3,700. To extend the improvement to the railroad bridge would increase the cost to about $5,000. The result would be obtainment of a channel for boats drawing 3 feet and of about 20 feet beam. This channel would be maintained during almost, if not quite, the whole year, until the falling in of other trees would again obstruct it. The advantage to commerce thus gained would be as follows:

The handling of about 3,800 bales of cotton would be facilitated, as it could then be taken by water to within 2 miles of a railroad depot, should no other be built, or directly to one, should the railroad company build at the railroad bridge. There is now much difficulty in hauling this cotton to Lafayette, or to one of the landings on the bayou in the direction of Abbeville, as the county roads are in a miserable condition. The average haul for this cotton would be diminished from about 6 miles at present to about 2 miles without, or about half a mile with, a depot at the railroad bridge.

The shipment of light freights, now worth about $40,000 annually, and the transportation of passengers from Abbeville would be facilitated. Thus eggs and poultry, of which considerable quantities (about 5,000 dozen of eggs per month) are sent from Abbeville, would have a much quicker trip to New Orleans than now by the weekly boat to Morgan City. It is not expected that there will be any reduction in freights. Leading citizens of Abbeville informed me that they understood that rates must be fixed by the railroad, which, either at Lafayette or Morgan City, must handle all their produce; but they are extremely anxious to have quicker transportation for men and light freights, to be secured by the establishment, in case of improvement, of a daily line of small boats between Abbeville and one of the two bridges—Pinhook or the railroad bridge.

This saving of time would be an encouragement to those desiring to extend their business, as well as an indirect saving of money on the business now transacted. Heavy freights might or might not go up the stream to Lafayette, as in any case the rates would be about the same, and time of less consideration. At present the rates by boat are about 10 per cent. greater than on freight delivered by the shipper at Lafayette; thus cotton is $1.65 via boat and Morgan City and $1.50 from Lafayette.

Since the railroad company thus controls the situation they might virtually prohibit the use of the improved water-way. It would probably be to their interest to prevent freight from going to Morgan City, thus giving them the short haul, and would encourage it in coming toward Lafayette. The large boat, the *Barmore*, would probably be prevented from coming even as high as she does now, and the railroad company would establish barge lines, such as it has in the Bayou Lafourche and other streams, serving as feeders for its business at Lafayette or at the new depot which it might establish at the railroad bridge.

Besides shortening the dirt-road haul of the 3,800 bales of cotton and giving expedition to movement of passengers and light freights, the principal benefit to be desired from the proposed improvement is in affording a good mail route to Abbeville. This town now receives its mail by a stage route, about 28 miles long, from New Iberia, a railroad town, 125 miles from New Orleans.

In the rainy season this route becomes almost impassable; mails are delayed a week at a time. Were the bayou improved, a daily mail might be established which would regularly supply six or seven thousand people with mail. Only a small portion of these seven thousand are in the town of Abbeville itself, but that number would probably be supplied from various post-offices that might be established along the bayou.

Summing up the commercial advantages, it appears that the only reduction in freight rates to be looked for is that due to saving 5 miles of dirt-road hauling in 3,800 bales of cotton. This may be said to be worth about $400, or nearly at the rate of 10 cents per mile per bale. The expedition afforded passenger and light freight traffic is, of course, of value, but it is a value impossible to be put into figures; and so of increased mail facilities, no one can doubt the great value to any community of rapid mails, but it is not reducible to exact figures.

Streams throughout the country are divided, by the policy of Congress, into two classes: those of a certain national importance, worthy of national money; those *not* of national importance, however important locally, and not worthy of receiving national aid. The line of distinction is difficult to draw, and the change from one class to the other a gradual, not a sudden one. In the case under consideration, all the facts relating to freight transportation show that while the improvement would be beneficial, the benefits are such as are usually considered purely local; and on account of the situation of the stream with reference to the general market, New Orleans, even the use of these advantages by the people are such as the Southern Pacific Railroad may completely control. On the other hand, the fact that the postal business of the country adjacent to the stream may be much facilitated by its improvement gives to it something of a national character, since the postal business is distinctly and exclusively under control of the General Government.

As a general commercial route, Bayou Vermillion, from Abbeville to the railroad bridge, is not of national importance, or worthy of improvement in the sense in which I understand those words to have been used in legislation on the subject.

As a mail route, it is worthy of improvement. This, however, may be a matter for the Post-Office, instead of the War, Department to consider.

Prospective commerce can not, with any certainty, be predicted as greater or less than present commerce. There is plenty of fertile land, free from overflow, bordering Bayou Vermillion. A larger population could be supported where now it is but scant. Whether such increase will occur soon or not it is impossible to say. The improvement proposed would have, probably, some encouraging influence in this direction.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

LETTER OF MR. W. B. BAILEY, EDITOR OF THE LA FAYETTE ADVERTISER.

OFFICE OF THE LA FAYETTE ADVERTISER,
La Fayette, La., November 17, 1886.

DEAR SIR: In accordance with promise I will attempt to give you some information concerning the Bayou Vermillion.

Some work on Bayou Vermillion is, without doubt, a great necessity for the people of the parishes of La Fayette and Vermillion, for several reasons.

The people of Vermillion Parish and along the bayou have no other outlet to a market but that stream, which at one time saw four or five steam-boats at its upper landing in regular trade. The trade is considerable. Right on its banks you can count four sugar-houses and six or seven cotton-gins, with several more some distance within a few miles of the banks, from the line of Vermillion Parish to Pinhook, 2 miles below this town.

The country is all filled up and settled by small farmers, who are self-sustaining and out of debt. As it is, the bayou being closed up at several places, these people have to haul their produce and freight from 2 to 15 miles to the Morgan Railroad, who, having no competition, extort exorbitant rates, to this extent, that whilst they only charge 40 cents per barrel for freight from New Orleans to Washington, La., they would charge these people 80 cents for carrying the same barrel 25 miles less.

It would also afford the Abbeville people an easier way of transportation to Morgan Railroad than by land.

There is another reason that should induce the Federal Government to do this work. Our bayou connects with the Teche and Fusilier, and a very safe and regular inland navigation can be inaugurated for our people in that direction, instead of the dangerous mode by the Gulf, and as a military precaution in case of war with a foreign nation—with a few improvements made in these streams—would be very necessary.

Opening this bayou, navigation again would give us some competition against the Morgan Railroad, and thus relieve our people to some extent from the exorbitant rates we have to pay to that monopoly in freights.

If opened through, the Teche might give an opportunity to connect with the Texas and Pacific Railroad and bring about a lively competition between that line of road and the Morgan Railroad for our freights, at the same time open a way to the inhabitants of the different bayous on the new line of communication.

The people of the parishes of La Fayette and Vermillion have been for many years looking for relief in that matter, but what little was done was not effective, and did not amount to anything in the way of opening the stream for steam-boats, and that relief is truly and very much needed by our people.

I merely make mention of stream above this place to call your attention to same, if any steps should be taken in that direction in future.

Hoping to have the pleasure of meeting you again at no very distant day, I remain,

Your obedient servant,

W. B. BAILEY.

Lieut. O. T. CROSBY.

S 20.

PRELIMINARY EXAMINATION OF MOUTH OF CALCASIEU RIVER AND OF CALCASIEU PASS, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., December 2, 1886.

GENERAL: The river and harbor act of August 5, 1886, required, among other things, that an examination be made of the "Calcasieu Pass, the two bars obstructing the navigation thereof," and of "mouth of Calcasieu River, the bar obstructing its mouth." An appropriation made by Congress at its last session permitted funds heretofore unavailable, on account of the wording of the act, to be used for removing two of the bars herein mentioned.

The third or outside bar, that in the Gulf, has not heretofore been a serious obstruction to navigation, but the wording of the act requiring the examination to be made, made it evident to me that Congress wanted an examination made of the outer bar.

Mr. Thomas L. Raymond, the assistant engineer connected with this office, was directed by me to make this examination, and his report is herewith. It will be seen from an examination of the tracing that the least depth of water at mean low tide on this outer bar is 6½ feet, while the water on the two inner bars was only about 3½ feet in depth. A contract is now in force to obtain by dredging a channel over the two inner bars having a least depth of 6 feet.

The depth of water on the outer bar is now as great as it has been for many years, but the depth is liable to vary in consequence of storms, which cause a shifting of the channel. The depth of water in Calcasieu Lake, which is about 15 miles long, is 6 feet, and even deeper water produced on the outer bar. The advantage to the commerce of the town of Lake Charles would be that vessels could load deeper in proportion to the increase of depth of water produced, and thus carry out very much larger cargoes of lumber than at present, thus enabling the lumber merchants of this locality to compete with those in other Gulf ports less favorably situated geographically, besides enabling vessels to find a safe harbor in the Calcasieu Pass when necessary.

On account of the shallow depths in Calcasieu Lake, it is still probable that the increased quantity of lumber produced for export in the event of an improved bar would have to be lightened before transfer to the sea-going vessel.

The estimated annual value of the output of lumber at Lake Charles is about $750,000; about one-half of this is transported by rail. Should deeper water be required on the outer bar, the most certain as well as satisfactory way of obtaining it would be by means of two jetties extending from the shore seawards, as indicated by Assistant Engineer

Raymond, each jetty to be about 1½ miles in length, the jetties to be of brush covered with stone, dredging to be used as an auxiliary aid in producing depth.

The estimated cost of the improvement to obtain a 12-foot depth is, in round numbers, $600,000. I believe from the facts stated that the harbor is worthy of improvement to the extent indicated, and that a greater depth than 12 feet is not demanded by any prospective demands of commerce for several years to come.

Should commerce increase sufficiently, when the improvement indicated has been completed, greater depths can then be obtained by simply extending the jetties further seaward. No further survey will be required until an appropriation be made by Congress for doing the work indicated. Should Congress desire the work done economically and expeditiously, then the whole amount should be appropriated at once, as the work can be completed, and ought to be, if done at all, in one year.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. THOMAS L. RAYMOND, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *November* 30, 1886.

SIR: I have the honor to make the following report upon the examination of the mouth of Calcasieu Pass, Louisiana, made September 19, 1886, with reference to the obtaining of deeper water across the bar which obstructs the passage from the "pass" to deep water of the Gulf.

Calcasieu Pass, the outlet of Lake Calcasieu, is something over 7 miles in length, with an average width of 600 feet and a good channel 16 feet deep for the greater part of this distance, interrupted by oyster reefs about 4 miles from the Gulf. The drainage of 3,600 square miles of territory, with an annual rainfall of 50 inches, finds its way to the Gulf through Calcasieu Pass.

Neither time nor opportunity was had for current observations during the examinations, but, as in all similarly situated waters, currents of from 2½ to 3 miles per hour are produced by the head of water remaining in the lake when the Gulf level is suddenly lowered 3 feet or more by the action of the wind and tidal causes. These currents, where confined sufficiently in the pass, have produced depths as great as 25 feet.

The bar at the mouth is composed of sand, which usually moves from east to west along the Gulf coast, and apparently is not of very great thickness, as soundings in depths greater than 8 feet always found soft bottom.

The shores on both sides of the mouth of the pass are alluvial in character, with a narrow sand beach on the west side extending only a few miles, indicating the westward movement of this sand-drift upon the characteristic alluvial coast formation.

Shoal sand spits extend from the shore to the outer slope of the bar on either side of the channel; they are about 1,000 feet apart, and between these the bottom rises from 12 feet depth in the pass to a little less than 7 feet depth in a distance of 2,000 feet; it remains almost level for a distance of 2,000 feet further, and then slopes gradually again to 12 feet depth in the 2,000 feet beyond. The slope in the Gulf beyond the 12 feet depth is about 1 foot in 250 feet, giving a depth of 18 feet at a distance of 1¼ miles from shore.

Comparisons with surveys of 1871 and 1876 show deeper water across the bar by nearly a foot at the present time than has been previously observed, and also that the channel is continuously shifting to the westward under the influence of the prevailing winds and flood tides. The currents in the pass, with its width of 600 feet, do not maintain a wide navigable channel of greater depth than 16 feet, so that it seems useless to estimate on a greater depth than this across the bar before the depths inside the pass are correspondingly increased.

To obtain a depth of 12 feet across the bar would cost probably only one-half as much as would be required to obtain 16 feet, and the former would meet all the requirements for some years to come.

The three methods available for obtaining a channel 12 feet deep across the bar are: (1) Dredging; (2) jettying; (3) dredging with protection by dikes.

Dredging.—To dredge a channel 12 feet deep, with allowance for 1 foot for backfill and slope 200 feet wide, would require the removal of 230,000 cubic yards of material, principally sand, from a bar in a very exposed position and made too rough for work by any wind south of northeast or northwest, and of greater rate than a moderate breeze. The cost under these conditions would probably not be less than 50 cents per yard, which would make the cost of the whole work not less than $120,000, including inspection expenses.

There is every reason to believe that work of this character would not be permanent, and that the fill from adjacent shoals of shifting sands and the sand-drift along the coast would necessitate redredging at intervals that could only be ascertained by experience. An addition of one-half the first cost per year for maintenance does not seem to be unreasonable.

On this basis $120,000 for the first year, with an addition of $60,000 per year thereafter, would be the least cost of such a work, which for ten years would represent a capital of $1,320,000 invested at 5 per cent.

Jettying.—Herewith is submitted a sketch showing the entrance to Calcasieu Pass and the depths upon the bar at mean low tide from the examination of September 19, 1886, with a few characteristic soundings from survey of 1876. Trial lines of the jetties for the purpose of calculating the cost are drawn in, 800 feet apart, the depths in the pass indicating that the prevailing currents confined to this width will produce the required depth of 12 feet.

The following is an estimate of the amount of material and cost of the same in place required to build two jetties on these lines. These estimates provide for a foundation of brush mattresses of varying width and not more than 3 feet in height, with a superstructure of riprap granite, built to a height of 2 feet above mean low tide, with a width at top of 10 feet and side slopes of 1 on 2, the projecting bermes of the foundation mattresses to be loaded with half a foot of granite.

Mattresses in place are estimated to cost $1.75 per cubic yard, and granite $4.50 per cubic yard.

The total cost, with 25 per cent. added to first estimate for contingencies, is in the neighborhood of $600,000. To this should be added $25,000 for such dredging as might be required should the unknown character of the bottom render it necessary.

Dredging with protection by dikes.—It seems certain that this bar is formed entirely by the gulf-shore drift, with no additions from the waters of the pass, little if any of the river sediment escaping from the large settling basin of Calcasieu Lake. A small initial saving might therefore be made in the cost of obtaining a 12-foot channel by locating the dikes, built on the same plan as the jetties just described, 2,000 feet apart, to place them along the crest of the shoals, on either side of the channel. This change of location would diminish their length as well as their height, and thus situated they would produce favorable conditions for dredging in almost any weather, and give a certain degree of permanence to the channel when obtained.

The cost of building these dikes is estimated at $500,000. Dredging a channel between them to a depth of 12 feet would then be reduced to probably 25 cents per cubic yard or $60,000 additional, making the total cost of the completed work $560,000. Of the three methods of improvement above noticed, the arguments of permanence, true economy, and susceptibility to future improvement at a minimum of expense are certainly in favor of the second, or that by means of jetties so placed as to concentrate the currents sufficiently to remove the bar between them.

Benefits to be obtained: With a channel 12 feet deep through this bar, admittance would be had to a safe harbor 600 feet wide and 4 miles long, in which vessels of this draught could load at all times without danger or delay.

The banks of the pass are sufficiently high for building purposes. As Calcasieu Lake is only 7 feet deep the products of the interior would have to be brought down to this harbor on barges or by rail. Lumber in large quantities is now shipped to gulf ports through the pass on light-draught schooners, which are too small to venture far from the coast or into the gulf at all, except in the best weather. The freights are, therefore, ruinously high, and these would be greatly reduced and trade materially increased were this improvement accomplished.

Very respectfully,

THOS. L. RAYMOND,
Assistant Engineer.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 21.

EXAMINATION AND SURVEY OF MOUTH OF BAYOU PLAQUEMINE, WITH A VIEW TO ITS CONNECTION WITH THE MISSISSIPPI RIVER BY LOCKS; ALSO BAYOU PLAQUEMINE AND OTHER CONNECTING STREAMS, TO FORM THE BEST ROUTE TO GRAND LAKE, LOUISIANA.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 28, 1887.

SIR: To comply with the requirements of the river and harbor act of August 5, 1886, I have the honor to submit herewith a copy of a report to this office from Maj. W. H. Heuer, Corps of Engineers, of the results of a survey, made under his direction, of the mouth of Bayou Plaquemine, Louisiana, with a view to its connection with the Mississippi River by locks, together with a copy of his report on the preliminary examination of the same, provided for in that act.

The appropriation for the improvement of the Mississippi River, made by the river and harbor act of August 2, 1882, to be expended in accordance with the plans and recommendations of the Mississippi River Commission, contained, among other special localities enumerated for improvement, that of a lock at the mouth of Bayou Plaquemine. For action thereon reference is made to the annual report of the Commission for the year 1884, printed as House Ex. Doc. No. 64, Forty-eighth Congress, second session, and also in Part IV of the Report of the Chief of Engineers for 1885.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

HON. WILLIAM C. ENDICOTT,
Secretary of War.

PRELIMINARY EXAMINATION OF MOUTH OF BAYOU PLAQUEMINE, WITH A VIEW TO ITS CONNECTION WITH THE MISSISSIPPI RIVER BY LOCKS; ALSO BAYOU PLAQUEMINE AND OTHER CONNECTING STREAMS, TO FORM THE BEST ROUTE TO GRAND LAKE, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., December 2, 1886.

GENERAL: The river and harbor act of August 5, 1886, required an examination of "mouth of Bayou Plaquemine with a view to its connection with the Mississippi River by locks; also Bayou Plaquemine and other connecting streams to form the best route to Grand Lake."

The examination having been assigned to me by orders from the Engineer Department, the records of previous examinations and surveys were looked up, and a full printed report on this very navigation route was found in the Report of the Chief of Engineers for 1885, Volume IV, page 2984 and following. This report was accompanied by maps, plans, profiles, and estimates made under the direction of Major Stickney, Corps of Engineers, and submitted to the Mississippi River Commission, and forms part of their report in the volume above referred to. Through the kindness of Major Raymond, Corps of Engineers, the maps, plans, profiles, etc., were transferred to me, and on November 29

Lieutenant Crosby, United States Engineer Corps, accompanied me over that part of the Plaquemine route requiring examination.

The surveys made by Major Stickney are so complete and satisfactory as to this route that if no changes had occurred since the survey was made no further surveys would be required; but within the past two or three months the Mississippi River banks have been caving to an unusual extent immediately in front of the town of Plaquemine, and considerable of this caving has occurred at the immediate site or head of the Bayou Plaquemine. Major Stickney's report did not furnish any estimate for protecting the bank of the Mississippi River near the site of the locks. Either the bank will have to be held by revetment or other protecting works, or the locks will have to be established well inland, and in the latter case annual or more frequent dredging will be required to free the approaches to the locks from sedimentary deposit. The probable cost of the locks and the best location for them can only be definitely determined by careful borings for foundation. Should the Plaquemine route be opened to navigation, the greatest benefit would result to all the planters on the Teche. The present water route from the Teche to New Orleans is, approximately, 425 miles in length; if the Plaquemine route were opened, this route would be shortened about 180 miles, or give for the products of the Teche a water route to market 245 miles long, instead of 425 miles as at present, and thereby lessen the cost of transportation of this, the richest sugar country in Louisiana. The estimated annual value of the output of the Teche country is $3,358,000. This is for the sugar and molasses alone; other products would probably bring the aggregate output to $4,000,000 per annum. Not more than 10 per cent. of this freight has of late years been carried to New Orleans by the all-water route; one reason for this is, that not more than one boat could make a living carrying freight 425 miles in competition with a railroad whose haul was only 125 miles. By shortening the water haul as above indicated, the boat or boats can carry for less money; the boat owners and others interested say they will transport for less money; the railroad will therefore have to reduce its freight rate, and thus directly benefit every planter in that section of the country. For the past five or six weeks the mouth of Old River has been practically closed to navigation on account of the extreme low stage of the water. Had the Plaquemine route then been opened, such boats as run up the Red, Black, Ouachita, Atchafalaya, and Bayous Tensas, Bartholomew, Macon, Bœuf, Cypress, Teche, and Courtableau, an aggregate length of over 2,000 miles of navigable streams would have been uninterrupted, and would have saved to the country and people interested a loss which may be roughly estimated at not less than $300,000.

On the maps made from surveys under Major Stickney can be seen localities on the line of the proposed improvement where it might be possible to save some money by reducing the amount of excavation indicated; this, however, will be offset, probably, by additional expense in removing stumps in the bed of the stream, plainly visible at the present stage of water in the bayou, purchase of property where the bayou has to be widened, and for the lock-site, together with the cost of the revetment necessary to hold the Mississippi River bank near Plaquemine. I am of opinion, based on this examination, and after a study of maps and plans available, that the improvement will cost, as estimated by Major Stickney, about $1,708,250, and that the navigation route is worthy of improvement.

The survey required to determine definite data relative to the lock-site and its cost, also the changes caused by caving banks which require revetting, etc., I estimate to cost $800; this, if possible, should be made available immediately, as it can be made more economically and accurately now than later on, on account of the extremely low stage of water.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF MOUTH OF BAYOU PLAQUEMINE, WITH A VIEW TO ITS CONNECTION WITH THE MISSISSIPPI RIVER BY LOCKS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., February 11, 1887.

GENERAL: I forward herewith report and tracing by Lieutenant Crosby, Corps of Engineers, being the result of his survey to determine a lock-site and bank protection at Plaquemine, La., as recommended in my report of December 2, 1886. Tracing mailed in separate package.

I agree fully with Lieutenant Crosby in his selection of lock-site and in his general plan and estimate of spur-dikes for bank protection.

Whether or not it will be desirable to build the locks without side-walls is as yet a matter so uncertain to my mind that I hesitate to make a recommendation on this point. It can be demonstrated that, by omitting the side-walls, the locks can be constructed at a cost of $150,000 less than with them, but the annual repairs to the wooden revetment, together with the cost of the revetment which may be necessary below the tail bay of the lock in consequence of having no side-walls, may incur an expense for maintenance which, if capitalized, may be greater than the $150,000 which the side-walls will cost; besides, should the side-walls in the future become necessary, their cost then will exceed the cost now, and during the time of their construction it is probable that the traffic through the canal will have to cease for several months.

This is a matter that, before action is finally determined upon, I should recommend be referred to a Board of Engineers.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT OSCAR T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., February 9, 1887.

SIR: I have the honor to report as follows upon an examination to determine site of proposed lock at Plaquemine, La., made under recent orders from you.

Detailed maps of the locality were already in possession of this office, these maps having been made about five years ago under direction of the Mississippi River Commission, and received by you from Major Raymond, Corps of Engineers, while he was on duty in this city.

On these maps was indicated the position of the lock, presumably that chosen by the assistant engineer or engineers who made the survey. The report of the survey is rather meager, there being no discussion of the reasons leading to the choice of the position assigned, nor for the choice of the particular kind of lock recommended, of which drawings accompany the maps. The only field-work remaining to be done consisted in the making of a few borings, of which none had been made, and some hydrographic work necessary for making a plan of shore protection, the banks of the Mississippi having caved so much within the last year as to inflict great damage on the town of Plaquemine, and threaten any structure which might be erected in that vicinity. This field-work I did between the 7th and 14th of January. The new shore-line, new levee-line, soundings, and borings have been indicated in red on that one of the Commission maps which is drawn to the larger scale.

Through the kindness of Mr. Dickinson, parish surveyor, I obtained shore-lines of 1819, 1831, and 1854, which are likewise shown in red, and which are valuable in showing the rate of caving throughout a long period of years.

An inspection of the map shows that the lock might be placed so far below the head of the bayou—say in the straight reach below the railroad bridge—as to make it highly improbable that caving would reach it within any period which need be considered.

Expense of bank protection would thus be avoided. But consideration of the following points will, I think, show the necessity of such work.

(1) Wherever the lock may be placed it will probably be necessary to construct what may be called harbor-works at the head of the bayou. Unless protected throughout a reasonable distance up-stream such works might be taken in rear by caving above and thus destroyed.

(2) There are good reasons—more fully discussed later—for placing the lock much nearer the river than the point above suggested; the selected point being such that the rate of caving being constant the river would reach the upper gate in about seventy-five years. No assurance can be had that the rate may not increase, bringing destruction to the lock in much less than seventy-five years. Hence, ordinary caution requires that the lock-site be protected.

In determining what kind of bank protection should be adopted it should first be considered which of the two classes, revetment or spur work, is best suited to the locality.

Aside from questions of relative merit as protections for the banks to which they may be applied, one of the controlling reasons, in many cases leading to the adoption of the first of these two systems, is the desire to leave unchanged current directions. In the present case this consideration need have little or no weight, as such deflection of the current as would be caused by protecting spurs could result only in an attack upon a barren and valueless point on the opposite side from and below the spot protected. This matter aside, their relative efficiency, permanence, and cheapness will determine between the two methods. On the Mississippi River, protective work, strictly defined with respect to purpose, has been almost entirely mattress revetment. The average loss on cost of work has been 26 per cent. But the contracting dikes are in fact protectors of banks, in some cases threatened or actually caving, in others not. They have been in general very successful in building new banks, as was intended, and thus protecting in the most effective way the original shore-line. Average loss on cost has been 22 per cent. Where the revetment has extended some distance above and below all danger, and well above low-water line, it seems usually to have afforded effective protection.

The best, perhaps the only, example of the use of spurs in very deep water, with sole purpose of protecting banks, is seen in the work now progressing at Gouldsborough Bend, New Orleans Harbor. These spurs, like the contracting dikes on the upper river, cause a deflection of current. They do not depend, as largely as do those dikes, on the growth of deposit, are not intended to secure greater depth, and do their whole work when they succeed in holding the bank. In construction they are quite different.

The project has not yet been completed, but results are thus far satisfactory. Indeed, the principle being one that has led to success in hundreds of cases, it was only a question of constructing spurs stable enough to resist the enormous forces developed in the deep waters of the Mississippi, and close enough together to keep the current away from the threatened bank.

No loss of material is reported.

It may be concluded that as to efficiency the two systems, when applied in the best manner, are of nearly equal value. As to permanence, the comparison is undoubtedly in favor of the spur work. There is indeed but slight difference between the percentages of loss of revetment and dike work on the upper river, the former being 26 per cent. the latter 22 per cent. But the dikes were specially constructed of light design, for silt-catching. The Goldsborough spurs, staunchly constructed for the same purpose in view at Plaquemine, show no loss at all. Work of similar character and for the same purpose, constructed on the Arkansas River by Captain H. S. Taber, and reported, page 1564, Volume II, Annual Report Chief of Engineers, United States Army, 1885, shows the same favorable result as to permanence, after being subject to trials as severe as ever occur on the Arkansas River.

As to initial cost, examination of reports of the Mississippi River Commission work discloses the fact that for an isolated piece of work of the magnitude required at Plaquemine, and in depths much greater than the average depth worked in heretofore, $40 per linear foot would be a fair estimate of cost. This figure makes allowance for purchase of necessary plant. In the Carrolton Bend, where conditions of depth and slope are similar to those at Plaquemine, the mattress used was 400 feet wide; supposing it to be of about the same character as the foundation mat of the spurs in Goldsborough Bend, its cost in place would be $30.40 per running foot; it would probably cost more per unit than that mattress, since it would require more stone to hold it in place.

The plant for the work, I have been personally informed by the assistant engineer in charge, may be estimated at about $30,000. As about 3,000 feet would require protection in this way, $10 per foot must be allowed for that item. The total cost of revetment thus reaches $120,000. It will not be necessary to place more than three spurs. In this harbor they are costing about $12,500 each, in depth about the same as those at Plaquemine. Estimating the same cost of plant, total cost is only $67,500.

It is confidently stated in the reports on the work here that with a little experience, and with more reliable contractors, this cost may be materially reduced.

The latest reports of the Mississippi River Commission, received since beginning this report, show a further recommendation of the spur-dike plan, in that it has been adopted for protective use in the deep water of Memphis Harbor. Whether the same details of construction be or be not adopted for the Plaquemine work, the Goldsborough work may be taken as furnishing a proper estimate of cost. As part of the lock project, I therefore recommend the protection of the Mississippi bank by three spur-dikes, at an estimated cost of $68,000. The positions of these structures are indicated on the map. As both bank and bottom may change considerably before commencement of work, these positions are subject to change.

In order to diminish as far as possible the deposit of sediment in the approach to the lock it will be advisable to construct harbor walls at the head of the bayou, extending downward and outward into the Mississippi, reaching probably a depth of 20 feet. Positions of these walls are indicated on the map. The inclination downstream and the considerable width between walls at the outer end are given with a view to obtaining eddy action, preventing deposit in the opening. The distance between the walls is diminished as the high-water bank is approached, securing here the maximum washing effect from passage of boats and from whatever current may be due to filling of the locks for passages. The up-stream wall may be constructed by driving two rows of piles 10 feet apart, those in the lower line being 4 feet, those in the upper 8 feet from center to center; the space between these piles to be filled with brush up to low-water mark; above low-water mark the piles to be sheathed with 2-inch stuff; the brush to be heavily weighted by stone, resting on the brush and held up between the piles by the sheathing.

The lower wall may be of one line of piles, sheathed to the bottom where the wall enters into and is backed by the present sand-bar; at the outer end this sheathing to go down to low-water mark. This wall will stand in practically dead water. The upper one will be exposed to a current much less than now passes over its site, by reason of the spur-dike proposed to be constructed just above. It resists this current by dead weight of brush and stone and by the hold of the piles. Consider the first 10 feet, measured from the outer end; suppose the water to be 20 feet deep throughout this section; at high water, 53 feet deep. Suppose a mean velocity of 5 feet per second against the opposed area of 530 square feet. The pressure due to current will be 12,720 pounds with a lever arm for overturning equal to 26.5 feet; the moment= 337,080 pounds. Suppose the layer of stone to be 10 feet thick, and of such sizes as to average 100 pounds to the cubic foot; suppose the compressed brush to average 10 pounds per cubic foot. The combined dead weight = 144,000 pounds, having for resistance to overthrow a lever arm of 5 feet, giving a moment of 620,000 pounds. There is thus a factor of safety = 2, without demanding of the piles anything more than to hold up brush or stone. By careful piling of large-size stones this can be reduced to safe limits, the up-stream piles having the assistance of the current pressure against them during high water; in low water both lines being bound together by tie-pieces, would resist together. The total length of wall may be taken at 200 feet. The stone filling would be required only for an average length × depth of 100 × 10, the weight being about 600 tons. The two walls would require 125 piles, 600 tons stone, 30 cords brush, 25,000 feet lumber; the total cost I estimate at $5,000.

Since the efficiency of steam-boat wheels and passage of water for lock-filling may be greater than is now anticipated for keeping clear the approach, it may be possible that no such harbor work will prove necessary. The slope of the bottom in front of the sand-bar is very steep; the entrance through the sand-bar may be made narrow and revetted. It is probable that, with or without harbor work, the formation of some deposit will make necessary the keeping of a small dredge-boat near the locks, a little extra work by which could be done at a very low rate. The bottom and currents in front of the bar may be affected by the spur-dike above, so that a year or two after construction of the dike other lines for the walls than those now indicated would be chosen. For all these reasons I believe that the subject of harbor works may be held in abeyance until after construction of the locks.

SITE OF THE LOCK.

The advantages of cutting across the bend, which begins about 1,000 feet below the head of the Plaquemine, are as follows:

(1) The expense of a coffer-dam is thus avoided.

(2) The lock may thus be placed nearer the river than if placed in the first straight reach of the bayou bend; this proximity to the river diminishes the area over which dredging will have to be done, and makes unnecessary the extension of levees, which would be required beyond the present dike if the high-water level of the river be admitted beyond that point.

(3) The sharp bend in the town would thus be entirely cut out of the navigated route.

The disadvantages are:

(1) The necessity of purchasing property.

(2) Increased excavation as compared with a site in the bed of the bayou. This increase is only with respect to the site proper, and it is completely offset by saving the excavation necessary for deepening the channel around the bend and opening the dike.

The item for purchase or condemnation of property would be a large one if the line as laid down on the drawing when received by this office were followed. That line carries the excavation across a valuable mill property, and across the Texas and Pacific Railroad only a few feet beyond their present bridge. The mill property, I learned from authentic sources, is worth about $60,000. It need not be destroyed, but would have to be removed. The present position is a very good one, and damage would result from a change. This continuing damage, together with loss due to interruption of business and actual cost of transfer, may fairly be estimated at $20,000. The cost of crossing the railroad would consist of the cost of a draw-bridge over the lock approach, damage due to any interruption of traffic, and increased cost of excavation by reason of the precaution necessary to be taken in passing under the track. One of these elements being uncertain no close estimate of the whole can be made. I assume, roughly, $50,000; it might be much more.

The whole of this sum and the $20,000 above mentioned may be saved by changing slightly the direction of the line as it crosses the bend; it can thus be made to avoid the mill and rejoin the bayou *above* the railroad bridge, thus throwing the burden of putting in a turn-bridge on the railroad company. The civil authorities granting right of way required of the company an obligation to build a draw-bridge when required by navigation interests. Instead, therefore, of the old line, I recommend one shown on the drawing, believing it to be cheaper by $70,000 than that first projected.

Along the new line the value of the property required is about the same as that on the old line up to the mill. A liberal estimate will not put this above $8,000.

Comparing a cut along this second line, then, with a site in the bayou, we have $8,000 to set against, first, the cost of a coffer-dam; second, the cost of levees; third, the cost of extra dredging; fourth, the disadvantage of having to navigate a bad bend. The coffer-dam required would be about 200 feet long and 20 feet high; the levee required to extend Mississippi high water to the first suitable site in the bayou bed would be about 6,000 feet long and 5 feet high. Without going into particulars, it is plain that these two items will cost more than the $8,000 for property, leaving still in favor of the cut the second indefinite but not unimportant items of diminished dredging and straighter route. This comparison has considered only the above-ground facts in the matter. It should be stated that the borings made show that, within the limited area in question, the substrata differs so little from point to point as to leave all sites equal, so far as foundation is concerned. The amount of pumping will also be about the same.

Results of the three borings are shown below:

	Reference.	Boring No. 1.		Boring No. 2.		Boring No. 3.	
		Material.	Remarks.	Material.	Remarks.	Material.	Remarks.
	95.0		In bed of bayou opposite market.	——	Surface =92.5. Point on line of lock-approach toward river.	——	Surface=93.0. Point on line of excavation across bend. Distant from bay on water about 450 feet.
			'	Sandy loam...		Loamy earth.	
	90.0		'	"		"	
			'	Stiff sand with some clay.			
	85.0		'	Wet sand.	Adjacent pond about this level.	Slushy sand.	
			Surface reference =82.5.	"			
		——					
		Very sandy loam.					
	80.0			Wet clay and sand, clay and sand, clay and sand drift.		Stiff clay and sand.	
		Sandy, wet.	Water about 28.0′ distant, standing at about 78.0.		Not slushy but wet.		
	75.0	Very wet sand.			——	Very wet sand and clay. Sand and clay stiff.	32.0′ piping went down about 2.0′ by its own weight when dropped in hole 16.0′ deep.
		"					
		Sand with clay.		Clay and sand very stiff; proportions of clay and sand vary slightly; bluish color.			
	70.0	Blue clay with some sand.				"	Sand predominates. Driving hard.
L. W. of river.		Sand and clay mixed.				"	
		Blue clay.	Quite hard driving.				
		"					
	65.0	"				"	Pipe broke, leaving one section in hole.
		B. C. with some sand.	Small bit of wood in clay.			——	
		"					
	60.0	"	A little wet.				Reference of surface points taken from drawing. H. W. of Mississippi=100.0′.
		"					
	55.0	"		——			
		Blue clay.	Stiff. Drives hard.				
	50.0	——	Bit of cypress log.				Driving with heavy sledge-hammers; movement of pipe generally from ½″ to ¼″. Pipe diameter =1.5″.

Besides the data thus tabulated, it is to be noted that careful soundings made by Humphrey and Abbott, parties with sampling-lead, indicated the continuance of the blue-clay stratum to a depth of 150 feet, and that the banks of the bayou, exposing the soil to a depth of about 15 feet in several directions within the area considered, indicate an almost perfect uniformity throughout this area (this uniformity is also observable in the table of borings); and that the considerable depths—35 and 45 feet—found close to the present bank, sometimes at points of last year's bank, indicate that if the caving is due to a stratum of material much softer than the clay, that stratum lies about 40 feet below low water.

Considering all the facts it may be concluded that in a pile foundation constructed in this soil each 12-inch round pile may be safely subjected to a load of 25,000 pounds. Otherwise expressed, a weight of 4,000 pounds per square foot of area may be put upon piles driven throughout the area, 3 feet between centers each way. This will involve an expenditure of about $15 for the support of every 100,000 pounds of superstructure.

Inspection of the boring record shows that wherever the lock excavation may be made, much seepage water must be contended with. It is probable that if the pond now existing between the sand-bar at the head of the bayou and the dike below were drained, this seepage would be considerably diminished. But much will remain, perhaps enough to require constant pumping, besides various temporary expedients for diminishing the inflow. Should the work be prosecuted and completed in one year, pumping at $15 per day, with initial cost of plant, would cost about $7,500.

THE LOCK.

Having considered the matters of shore protection, harbor works, site of lock, and nature of foundation, it is next in order to consider the details of the lock itself.

The drawings transferred to this office show plans for a double brick lock; the total lift of 32 feet (possible in case the Atchafalaya be separated from the Red and Mississippi) is divided between the two locks of the flight, thus bringing the lift within limits of preceding practice. Sliding gates are represented, though without detail.

There are three locks now in existence giving outlet from the Mississippi. Two of these are opposite the city, one about 50 miles below. Those near the city have a lift of about 15 feet, the one below considerably less. The gates in all are of various but ordinary construction. The feature to which attention is called is that these locks have no side-walls. There being no question as to the quantity of water supply, and the commerce not being such as to make important the delay for filling extra volume, it was determined in the interest of economy to omit the usual side-walls. Two of these locks are in constant operation; the third failed, I believe, on account of insufficient foundation. The maximum lift to be overcome at Plaquemine is about twice that overcome by the lock now operating opposite the upper part of this city. The length and breadth required would be considerably greater, but these are not elements whose increase would, of itself, make necessary the construction of side-walls. Nor does the increase in height of gate or the greater depth of excavation for the second lock (from the river) create such necessity.

As it is desirable that this report be finished soon, I can not go into detailed estimates, but will only state that inspection of the locks successfully operating, and investigation of the conditions under which they were, and the Plaquemine locks would be, built, lead me to believe that economy would be attained without sacrifice of efficiency if, instead of opposing the great water pressure to be met by dead weight of masonry, this pressure be diverted against the natural sides of the excavation, as is the case in every river. These sides should be inclined, say 2 on 1, and planked, thus preventing sliding, excess of seepage, and wash from filling valves. The subject will be more fully studied before submission of a project for beginning the work. Such a plan would result in a saving of about $150,000 on the double lock, making the estimate, thus corrected, about $250,000.

ROUTE TO THE GRAND RIVER.

The estimates for this improvement submitted to the Mississippi River Commission were based on lines for excavation found represented in the drawings. In projecting a channel down Bayou Plaquemine, those who made the estimates seem to have adopted some minimum radius of curvature for the route, and if at any bend of the bayou a curve was found less favorable than that determined upon, excavation is directed against the bank, thus reducing the curvature.

This method would certainly secure a perfect navigation route, but I do not think the interests involved demand so much, while increase of initial cost may defeat the whole project.

It is to be remembered that Bayou Plaquemine, before its closure, was navigated by large steam-boats, often with the disadvantage of a heavy current. I recommend that these projected bank-cuts be omitted, save in one or two cases, from the estimates.

I have estimated the diminution that may be effected without in any way relinquishing the idea of obtaining a good navigation route, and find it to be about $700,000, which, at the estimated cost per yard, amounts to about $140,000. My estimate for this work is $625,000 instead of $782,698, the previous estimate. It is to be understood that this will secure a channel of ample width and depth. Something less perfect might answer the first needs.

GRAND RIVER.

The estimates for work in Grand River are such as aim at like perfection as referred to above. The river is now navigable and navigated. The construction of the locks would cause a greater number of vessels to frequent it, and the improvement provided for in the estimates might then be wisely made. A considerable part of the work should be done during the lock construction.

ATCHAFALAYA RIVER.

There is an estimate of $108,000 for removal of snags and rafts in the Atchafalaya. This river, like the Grand, is also navigable and navigated. Its improvement as indicated would be beneficial.

CONCLUSION.

The lowest estimate previously submitted, based on a lock of concrete (Louisville cement), perfecting route in Bayou Plaquemine as explained (excavation of 3,557,720 cubic yards at 20 cents), securing channel in Grand River 150 feet wide, and removing obstructions in the Atchafalaya, amounts to $1,421,350. This includes no estimate for shore protection, harbor works, or condemnation of property, whereas this last item would have been considerable along the lines originally chosen. Introducing these items, but deducting for others as explained above, the estimate becomes $1,214,350. Of this, $254,000 is for improvement of the Grand and Atchafalaya rivers; the whole of this sum might be beneficially expended, but only a part would be required at the start.

The first appropriation for the work should be $1,000,000.

Very respectfully, your obedient servant,

OSCAR T. CROSBY,
First Lieutenant, Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

APPENDIX T.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship-channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Buffalo Bayou, Texas.
5. Mouth of Brazos River, Texas.
6. Pass Cavallo Inlet to Matagorda Bay, Texas.
7. Aransas Pass and Bay, up to Rockport and Corpus Christi, Texas.
8. Harbor at Brazos Santiago, Texas.
9. Protection of river-bank at Fort Brown, Texas.

EXAMINATION.

10. Cedar Bayou, Texas; where it empties into Galveston Bay.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., August 6, 1887.

SIR: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The work of construction upon this improvement was last suspended in April, 1884. The project under which it was being prosecuted was revised by the Board of Engineers in their report, dated January 21, 1886. Under the new project the object of the improvement is to deepen the channel so as to admit sea-going vessels of the deepest draught, the natural depth upon the bar at mean low tide being about 12 feet. It is proposed to accomplish this by the construction of two jetties built to a height of 5 feet above low water, extending out to a depth of 30 feet, and having an interval between them at their outer ends of 7,000 feet. The action of the jetties is to be supplemented by dredging if necessary.

The order of construction is to first raise the present south jetty to its full height, 5 feet above low water, then build the north jetty out to the crest of the bar, and then complete both jetties to their full length. The estimate of cost for completing the two jetties to the crest of the bar is $3,000,000, and for completing them to 30 feet depth beyond the bar is $4,000,000 more, or $7,000,000 in all.

A contract was entered into on the 22d of April with A. M. Shannon & Co., for raising the old south jetty, beginning at the shore end and completing the work as far as the available funds would carry it. By the terms of the contract the delivery of materials was to begin not later than June 1, but at the end of the year the contractors had only just completed their arrangements. A track had been laid connecting the railroads in Galveston with the jetty, by means of which the stone can be loaded upon the cars at the quarry, in the interior of Texas, and unloaded in place upon the jetty. The materials are to be stone and clay, the latter constituting a core about 8 feet thick, intended to serve the double purpose of preventing leakage through the jetty and of economizing stone. The stone constituting the outer surface of the mass is to be in blocks weighing not less than 1 ton each for the portion of the jetty to be constructed this year.

A resurvey of the bar and harbor was made in April and May. The channel depth upon the outer bar was found to be 12¾ feet, and that upon the inner bar 20½ feet, both at mean low tide.

The funds estimated for continuing the work during the fiscal year ending June 30, 1889, are to be applied to building both jetties out to the crest of the bar, using teredo-proof material throughout, and increasing the size of the blocks and the dimensions of the jetties as the works advance into deeper water. The sum asked for is $3,000,000. No very extended explanation of this recommendation seems to be required. A present annual trade of $73,000,000 and a prospective trade of vastly greater proportions, is hampered by an obstruction which it is in the power of the Government to remove. The necessity of the improvement is notorious. The evil results of attempting its removal with inadequate means are almost equally notorious. It is submitted that the interests at stake require that the work should now be undertaken seriously.

The commercial statistics of the port will be found appended.

The original estimated cost of this work, as revised in 1886, is	$8,478,000.00
The aggregate amount appropriated to July 1, 1887, is	1,778,000.00
The amount actually expended is	1,481,782.84

In addition to this there was expended the sum of $100,000 subscribed by the city of Galveston.

The work is located in the collection district of Galveston. The nearest light-houses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

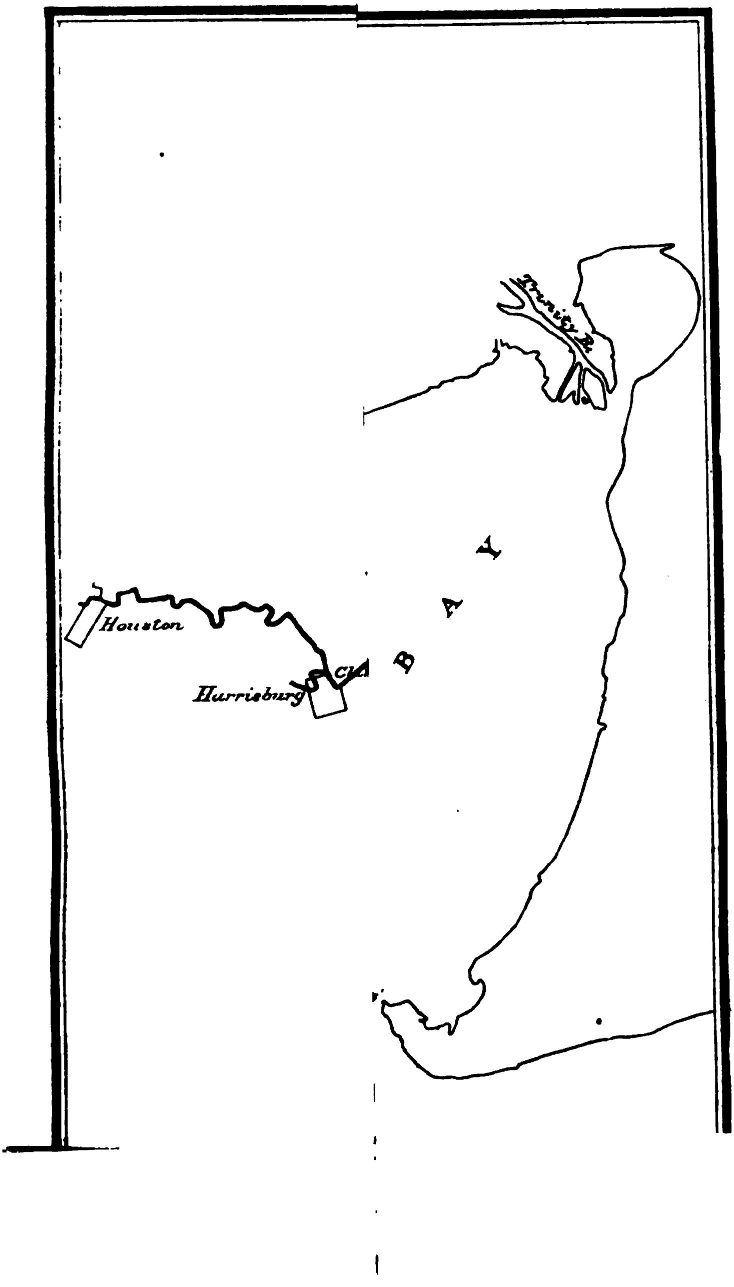
The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1887, was $172,894.17.

Money statement.

July 1, 1886, amount available	$96.98
Amount appropriated by act approved August 5, 1886	300,000.00
	300,096.98
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,879.82
July 1, 1887, amount available	296,217.16
Amount (estimated) required for completion of existing project	6,700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	3,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Plate 1



Abstract of proposals for constructing a jetty at entrance to Galveston Harbor, Texas, received in response to advertisement dated March 10, 1887, *and opened April* 16, 1887, *by Maj. O. H. Ernst, Corps of Engineers, at Galveston, Tex.*

No.	Names and addresses of bidders.	41,500 cubic yards ordinary riprap, per cubic yard.	36,600 cubic yards blocks of stone, per cubic yard.	16,300 cubic yards clay, per cubic yard.	Amount.
1	John Satterly, Englewood, N. J	$4.28	$5.88	$3.98	$457,702
2	Charles Clarke, Galveston, Tex	5.05	6.24	2.08	471,863
3	Rittenhouse Moore, Mobile, Ala	4.54	7.70	1.50	494,680
4	*A. M. Shannon & Co., Galveston, Tex	2.60	4.40	1.70	296,650
5	Gustav Wilke and John W. Rickey, Austin, Tex	2.90	4.73	1.20	313,028
6	Louisiana Jetty and Lightering Company, New Orleans, La	2.85	4.80	1.55	319,220
7	T. J. League, Galveston, Tex	3.58	5.86	1.75	391,571

* Lowest—accepted.

COMMERCIAL STATISTICS OF THE PORT OF GALVESTON DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

From Charles C. Sweeney, esq., collector of the port, it is learned that the—

Number of steam-vessels entered was	250
Number of sail-vessels entered was	296
Total number of vessels	546

having a total tonnage of 446,711 tons. The total value of their cargoes was $27,903,000. They carried 3,000 passengers.

The number of steam-vessels cleared was	256
Number of sail-vessels cleared was	238
Total number of vessels	494

having a total tonnage of 444,801 tons. The value of the cargoes cleared for foreign ports was $18,899,701. No record of cargoes for domestic ports is kept at the custom-house. The greater portion of this trade is conducted in the vessels belonging to the Mallory and Morgan lines of steamers. From the agents of these lines it is learned that the approximate value of the cargoes taken out during the fiscal year was for—

The Mallory line	$16,150,000
The Morgan line	10,922,000

The total sea-going trade of the port during the year was therefore approximately $73,874,701.

The majority of the vessels engaged in this trade draw from 15 to 20 feet of water when fully loaded.

In addition to these there are a large number of small schooners drawing 5 feet or less engaged in the coasting trade; no record of which is kept.

T 2.

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

The Ship-Channel in Galveston Bay is the result of an attempt to make a sea port upon Buffalo Bayou, at or near Houston, some 60 miles from the Gulf of Mexico. The water-way of which it is one link is shown upon the accompanying sketch. (Plate I.) The other links are the canal across Morgan's Point, the San Jacinto River, and Buffalo Bayou. The canal across Morgan's Point, called Morgan's Canal, was constructed by, and is the private property of, the Buffalo Bayou Ship-Channel

Company.* This company also dredged a channel out into the bay for a distance of 5 miles from the southern extremity of the canal, which channel is known as Morgan's Cut. Vessels using the canal are charged tolls. The campany agreed in 1881 to surrender to the United States their work at Morgan's Point, together with their charter and their rights under it, upon the completion by the Government of the Ship-Channel in Galveston Bay.

The plan adopted for the work consists of dredging a channel 100 feet wide and 12 feet deep, upon the lines shown upon the sketch, the average natural depth being about 8½ feet. The length of the proposed channel is about 18¼ miles, measuring from the 12-foot curve in Bolivar Channel to the southern extremity of Morgan's Cut. The original estimate of the cost of such channal was $446,326.42. The total amount appropriated up to and including the act of August 2, 1882, was $446,500. Dredging was carried on in the years 1872 to 1876, 1879, 1880, 1882, and 1883, the total amount expended being $286,629.50. The result was the making of deep cuts through portions of the distance, which were partially obliterated by natural causes before the other portions were deepened. An examination made in October, 1882, of the cut through the lower bay led Major Mansfield, the officer in charge, to believe that the results were not such as to justify going on with the work. It was accordingly suspended at the termination of the contract then in force, in June, 1883, and the facts were reported to Congress. The unexpended balance then remaining available was $159,870.50. A more detailed history of the operations up to that time may be found in the Annual Report of the Chief of Engineers for 1883, pages 1076-1082.

The next river and harbor act, that of July 5, 1884, contained the following item, viz:

> Improving Ship-Channel in Galveston Bay from Morgan's Cut to Bolivar Channel, continuing improvement, for which purpose the balance now remaining of the money heretofore appropriated for this work is hereby directed to be expended by the Secretary of War in the completion of said channel in accordance with the plans heretofore adopted, and in marking out said channel by piles or stakes so as to enable navigators to find the same without difficulty: *Provided*, That no part of said money shall be so expended until the Secretary of War shall be satisfied that the Buffalo Bayou Ship-Channel Company has relinquished or abandoned to the United States, forever, all their franchises and any and all right to collect or impose tolls or charges from any part of said Ship-Channel, or Buffalo Bayou.

The company not having relinquished their franchises and right to collect tolls, nothing was done under this act.

The next river and harbor act, that of August 5, 1886, contained the following item, viz:

> Improving Ship-Channel in Galveston Bay, Texas, from Morgan's Cut to Bolivar Channel, continuing improvement, for which purpose the balance now remaining of the money heretofore appropriated for this work is hereby directed to be expended by the Secretary of War in the completion of said channel in accordance with the plans heretofore adopted, and in marking out said channel by piles or stakes, so as to enable navigators to find the same without difficulty.

Which was a repetition of the instructions of 1884, except that the final condition was omitted. The work could therefore proceed without exacting of the Buffalo Bayou Ship Channel Company any change in the terms of their agreement of 1881.

As there had been no survey of the lower bay since October, 1882, and none of the upper bay since the work was suspended in June, 1883, but little was known about the actual condition of the channel, except in a general way that it had largely deteriorated. A resurvey was a necessary preliminary to any intelligent project for the continuation of the work. It was begun in February, under the authority contained in your indorsement of December 10, 1886, upon my letter of December 3, 1886. The party was in charge of Mr. H. C. Ripley, assistant engineer, who is entitled to credit for skillful and energetic management. The field-work was completed March 15. By the end of May the maps, though not entirely finished, were sufficiently far advanced to furnish the data, the procurement of which was the object of the survey.

---

* The charter of this company is forwarded with the report upon Buffalo Bayou herewith.

The work between Bolivar Channel and Redfish Bar, a distance of about 9.43 miles, was done in 1879 and 1880. The average depth at the completion of the work in 1880 was 11.56 feet. The present average depth is 9.04 feet. The average depth in the bay near the cut in 1880 was 8.98 feet, which gives an average depth of cutting 2.58 feet. There is left remaining of this at the present time .06 foot, or practically nothing. The average depth in the bay near the cut is found now, however, to be only 8.58 feet, which seems to indicate a general shoaling outside the cut, as well as in it, of .4 foot since 1880. If this be added to the .06 foot there will be .46 foot as the total increase of depth over what would exist if no work had ever been done. But as the object of the work is to obtain an absolute depth and not a relative depth, it may be said that no progress has been made upon this portion of the line.

The portion of the channel through Redfish Bar, measuring about 2.11 miles, was excavated in 1872 to 1876. The survey shows that while there has been an increase in depth at some places and a decrease at others, the channel has upon the whole exactly maintained itself, the average depth being 14.5 feet in 1877, and the same now. The maintenance of the cut here is due to the concentration of the flow between the upper and lower bays. No such favorable conditions are found elsewhere.

The part between Redfish Bar and the southern extremity of Morgan's Cut, about 6.81 miles in length, was excavated in 1882 and 1883. The average depth at the completion of the work in 1883 was 13 feet. The present average depth is 9.72 feet. The average depth upon the line of the cut before the work was begun was, in 1877, 8 57 feet, which gives an average depth of cutting 4.43 feet. There is left remaining of this at the present time 1.15 feet.

As the works at Morgan's Point are to be transferred to the United States in a certain contingency, the survey was extended over Morgan's Cut and Morgan's Canal. The average depth in Morgan's Cut was, in 1877, 12.86 feet. It is now 8.42 feet. The average depth in Morgan's Canal is found to be 19.2 feet, which is an increase of .9 foot since 1877, when it was 18.3 feet.

The survey developed the fact that the 12-foot contour in Bolivar Channel has receded southward about 2,400 feet. To complete the work it will be necessary to extend the excavation that far beyond its original terminus.

It appears, therefore, that out of the total length of channel excavated—18⅜ miles—9.43 miles have been obliterated, 2.11 miles have been fully maintained, and the remaining 6.81 miles have deteriorated 75 per cent., and the length of the channel must be increased 2,400 feet.

The rate of deterioration has not been uniform. An examination of the cut between Bolivar Channel and Redfish Bar was made in October, 1882, by which it was ascertained that about three-quarters of the work had been undone at that time, which was only two and one-third years after its completion. (See Annual Report of the Chief of Engineers for 1883, pages 1079, 1080.) The remaining quarter has disappeared in the four and two-third years since October, 1882. It is, as might be expected that the deeper the channel is below the general level of the bottom of the bay the more rapidly it will fill up, in cases like this where there is no concentrated flow in the channel. It is probable that more of the filling noted between 1880 and 1882 occurred in the first year than in the second. If the channel between Bolivar Channel and Redfish Bar be maintained at the full depth of 12 feet it will require the removal each year of not less than 30 per cent. of the amount originally excavated.

The deterioration between Redfish and Morgan's Cut has been less rapid than in the lower bay. It amounts to about 75 per cent. in four years, or 19 per cent. per year, if the rate of deterioration were uniform. But as the rate must have been greater the first year than in subsequent years, it is moderate to estimate that the maintenance of a channel 12 feet deep would require the removal each year of not less than 25 per cent. of the amount originally excavated.

Here are exact facts, which leave but little scope for theory or opinion as to the amount of work which will be required to maintain the channel, or as to the necessity, when once the excavation is begun, of pushing it through to completion rapidly and then making the work of maintenance continuous.

It sometimes happens that a temporary deepening of a channel will be of value to vessels using it, even if it subsequently return to its original condition, because it enables them to load to a deeper draught for a longer or shorter period. Such is not the case here. The design is to create a commerce which does not now exist; that is, to provide a channel for sea-going vessels of deep draught such as do not now visit Houston or cross the bay at all. The natural depth is sufficient for all vessels which now navigate the bay, loaded to their fullest capacities. No useful result can be obtained from expenditures upon this work until it is completed and such provision made for its maintenance as will inspire confidence in its permanency as a highway of commerce. Important trade will not follow an uncertain highway. To half finish it, or one-quarter finish it one year, and then leave it to be continued at some indefinite time in the future, is a waste of money. There should be on hand when the work is begun funds sufficient to carry it through and maintain it at least one year.

It was found that the amount of excavation required to make a channel 100 feet wide and 12 feet deep from Bolivar Channel to Morgan's Canal, which includes Morgan's Cut, would be 1,468,909 cubic yards, and that the amount required annually for maintenance would be 399,183 cubic yards. The cost of the excavation per cubic yard will vary somewhat with the size of the contract and the degree of competition among contractors. The work already done has cost. including all contingencies, about 25 cents per cubic yard. At this price the first cost of the excavation would be $367,227.25, and the annual cost of maintenance would be $99,795.75.

Believing it to be useless to begin the work with the funds available, I recommended in my report of May 30 that their expenditure should be deferred until they should be largely increased by further appropriations. This recommendation was disapproved "by reason of the mandatory terms of the act of August 5, 1886, directing its expenditure," and I was ordered to begin work with as little delay as practicable.

Proposals for doing the work have been invited by public advertisement, bids to be opened July 20, 1887. It is expected that a contract can be let and the work be begun by the middle of August. There should be no difficulty in completing the contract by the 1st of March, 1888.

The estimate, $317,000, submitted for continuing the work during the year ending June 30, 1889, is the amount required to complete the original excavation and to maintain it one year. With this sum and with regular appropriations thereafter, the work can be carried to a successful completion. With a sum much less than this, or with irregular appropriations thereafter, the work is, in my judgment, entirely impracticable.

No commercial statistics for this work can be given. Some of the best commercial minds in Houston believe that the advantages to be derived from enabling sea-going ships to reach Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. In the report upon the improvement of Buffalo Bayou herewith are given some statistics of the freight carried upon that stream. It is carried in barges drawing 5 feet when fully loaded, and towed by tugs drawing 7 feet or less. These cross Galveston Bay, but the depth of water is already sufficient to accommodate them. A large proportion of this freight would be loaded directly upon sea-going ships if they visited Houston.

The original estimated cost of this work as here revised is	$813,553.67
The aggregate amount appropriate to July 1, 1887, is	446,500.00
The amount actually expended is	291,923.18
The amount annually required for maintenance after the completion of the original work is	99,795.00

The work is located in the collection district of Galveston. The light-houses on or near the line of work are at Bolivar Point, at Fort Point, at half Moon Shoal, and at Redfish Bar.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1887, was $172,894.17.

Money statement.

July 1, 1886, amount available	$159,870.50
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	5,293.68
July 1, 1887, amount available	154,576.82
Amount that can be profitably expended in fiscal year ending June 30, 1889	317,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

T 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

There has been no appropriation for this work since that of August 2, 1882. The balance available at the beginning of the fiscal year, $311.65, was expended in making an examination of the work at the mouth, and in office expenses. The revetment at the mouth has received some damage from driftwood, and from storms, and the channel has shoaled in some places to 4½ feet at mean low tide. Owing to the softness of the bottom, a draught greater than 4½ feet can be carried through.

The revetment requires repairs and extension, and additional dredging is needed. This work is estimated to cost $25,000, which is in excess of the balance of the original estimate remaining to be appropriated. The original estimate is accordingly revised.

The trade is carried on entirely in schooners. Thirty-one schooners visit the river. They all trade with Galveston. Their tonnage ranges from 3 tons to 35 tons each. The majority draw about 4 feet when fully loaded. One or two can be loaded down to 4 feet 6 inches. It is a very rare thing for any vessel to go higher up the river than Moss Bluff, 20 miles from the mouth. The freight carried during the year was valued at about $220,000, and the freight charges were about $49,000. A statement of the commerce of the river has been furnished by Mr. Landon G. Chambers, of Wallisville, Chambers County, Tex., which is hereto appended.

The original estimated cost of this work, as here revised, is	$59,500
The aggregate amount appropriated to July 1, 1887, is	34,500
The amount actually expended is	34,500

The work is located in the collection district of Galveston. The nearest light-house is at Redfish Bar.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1887, was $172,894.17.

Money statement.

July 1, 1886, amount available	$311.65
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	311.65
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATEMENT OF THE COMMERCE OF TRINITY RIVER, TEXAS, FOR THE YEAR ENDING JUNE 30, 1887.

[By Landon G. Chambers, of Wallisville, Chambers County, Tex.]

Freight carried during the year.

Articles.	Quantity.	Value.	Freight charges.
Wood .... cords	18,000	$72,000	$36,000.00
Cotton .... bales	1,000	45,000	1,000.00
Charcoal .... sacks	40,000	20,000	4,000.00
Cotton-seed .... tons	800	7,200	1,600.00
Hides	5,000	7,500	1,250.00
Alligator hides	3,000	2,500	450.00
Live stock .... head	1,000	6,000	1,000.00
Chickens .... dozen	1,200	2,400	480.00
Eggs .... do	25,000	2,500	500.00
Butter .... pounds	1,000	200	40.00
Tallow .... do	500	40	10.00
Wool .... sacks	50	1,800	37.50
Bones .... tons	10	90	20.00
Potatoes .... bushels	1,500	1,500	300.00
Sweet potatoes .... do	3,000	1,500	300.00
General merchandise .... barrels	10,000	50,000	2,500.00
Total	....	220,230	49,487.50

T 4.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Buffalo Bayou is a tide-water stream, emptying into the San Jacinto River at Lynchburgh, about 25 miles below Houston. It is one link in the water-way which connects Houston with Galveston and the Gulf of Mexico. It is shown upon the sketch (plate 1) which accompanies the report upon the ship-channel in Galveston Bay, herewith. White Oak and Simms' bayous are two of its tributaries, the first entering it at Houston, and the second at a point about 11 miles below the first. The ultimate object of the improvement, as projected in 1880, is to secure a channel 12 feet deep and 100 feet wide, as in the case of the work in Galveston Bay, the aim being to admit sea-going ships to Houston. Below the mouth of Simms' Bayou these dimensions are found in nature. It is between White Oak and Simms's bayous that improvement is required. The banks here are high and generally stable, though occasionally subject to land slides. The surface width is generally greater than 100 feet, but there are some exceptions to this rule. The depth in the center of the channel is usually 9 feet or more at ordinary tides, but there are occasional shoals upon which as little as 6 feet is found, and during "northers" the surface is sometimes lowered several feet. At some points navigation is obstructed by the sharpness of the bends. It is endangered also by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

There is upon the bayou a large and important traffic, carried on principally in barges towed by tugs. The tugs draw 7 feet or less, and the barges, when fully loaded, draw about 5 feet. While this trade can be economically carried on with less dimensions of channel than those contemplated in the project, it is greatly benefited by the partial improvements which may be made in the earlier stages of the work. Useful results from the expenditure of the appropriations can be obtained in advance of the full completion of the work. A depth of 9 feet at ordinary tides will generally insure a sufficient depth during "northers." The enlargement of the channel and the removal of snags and overhanging trees, and the easement of bends, is of direct and immediate benefit to commerce. The method of conducting the work therefor differs from that followed in the case of the ship-channel in Galveston Bay. Instead of excavating a portion of the channel to its full dimensions, those obstructions which impede the present navigation are removed first. A new supply of sunken logs is found annually, and considerable shoaling, from surface wash, also occurs annually.

No work was done upon the stream during the year. On the 21st of May a contract was entered into with John J. Atkinson, of Houston, Tex., under which work is to be resumed July 1. It is proposed as far as the available funds will go, to widen the water-way where the width is less than 100 feet, and to deepen the channel where it is less than 9 feet at mean low tide, by dredging, to ease the sharpness of bends by cutting off the points, by scraping, and dredging; and to remove such sunken logs and stumps from the bed, and such overhanging trees from the banks, as may interfere with navigation, all the work being located between White Oak and Simms' bayous. The estimate, $100,000, for continuing the work during the fiscal year ending June 30, 1889, is to be applied in a similar manner.

It is reasonably certain that the amount estimated for the completion of the present project, which has heretofore accompanied the annual reports upon this work, will not be sufficient for that purpose. To make a new estimate would involve a resurvey, which is expensive. Moreover, it is impossible to make an accurate estimate of what the final cost will be, if the work be prosecuted, as heretofore, under small and irregular appropriations. As the available funds are limited, and can not well be spared for a survey, I have thought it proper, with this explanation, to retain the old estimate.

The Buffalo Bayou Ship Channel Company have acquired rights from the State of Texas, in connection with this stream, as in the case of the ship-channel in Galveston Bay. To show exactly what these rights are, I have procured a copy of the charter of the company, which is hereto appended. Under this charter the company seems to have the right to continue the improvement, taking it at any stage short of that where vessels drawing 9 feet can visit Houston, and then having made the stream navigable for such vessels, charge tolls upon all vessels, however small their draught. Although the company has shown no disposition to take advantage of this right, it is submitted that the right should be extinguished. Proper compensation should, of course, be made.

The principal trade of the bayou is carried on by the Houston Direct Navigation Company. A statement of the freight carried by them during the year is hereto appended.

Schooners engaged in the lumber trade with the Louisiana coast frequently arrive at Houston, but I have not been able to obtain any reliable statistics of that trade. It is believed to be but a small percentage of the total.

The original estimated cost of this work was	$[illegible]85, 299. 75
The aggregate amount appropriated to July 1, 1887, is	118, 750. 00
The amount actually expended is	100, 676. 03

The work is located in the collection district of Galveston. The nearest light-houses are those in Galveston Bay. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1887, was $172, 894. 17

Money statement.

July 1, 1886, amount available	$433. 75
Amount appropriated by act approved August 5, 1886	18, 750. 00
	19, 183. 75
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1, 109. 78
July 1, 1887, amount available	18, 073. 97
Amount that can be profitably expended in fiscal year ending June 30, 1889	100, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for improving Buffalo Bayou, Texas, received in response to advertisement dated March 24, 1887, and opened April 23, 1887, by Maj. O. H. Ernst, Corps of Engineers, at Galveston, Tex.

No.	Name and address of bidder.	Character of work.	Price.	Amount.
			Cents.	
1	John J. Atkinson, Houston, Tex	Dredging material under water, 50,000 cubic yards....per yard..	22	$13, [illegible]
		Dredging and scraping material above water, 12,500 cubic yards ....per yard..	20	
		Removing sunken logs, 2,000 cubic feet....................per foot..	5	
		Removing overhanging trees, 250 cubic feet ....per foot..	4	
		Removing such stumps as may be necessary, per cent. above actual cost to the contractor.......	Cost	

Only one bid received—accepted.

CHARTER OF THE BUFFALO BAYOU SHIP CHANNEL COMPANY.

AN ACT authorizing the construction of a ship-channel from Bolivar Point to the city of Houston.

Whereas the late constitutional convention of this State, on the 23d day of January, A. D., 1869, passed a declaration entitled "A declaration incorporating the Ship Channel Company from Bolivar Point to Houston," which said declaration purported to create A. S. Richardson, W. J. Hutchins, T. H. Mundine, John Shearne, T. W. House, R. O. Love, W. M. Rice, A. Groesbeck, J. R. Morris, H. R. Allen, S. Harper and their associates a body corporate and politic, under the name and style of the "Buffalo Bayou Ship Channel Company;" and whereas the parties named in said declaration and their associates have organized as a company, in accordance with the terms of the said declaration, and have done numerous acts towards the construction of the ship-channel contemplated by the said declaration; and whereas doubts exist concerning the force and effect in law of the said act of the said constitutional convention; and whereas the construction of a ship-channel as contemplated by the said declaration will greatly promote the commercial, agricultural, manufacturing, and other interests of the State of Texas: Therefore,

SECTION 1. *Be it enacted by the legislature of the State of Texas*, That A. S. Richardson, John Shearne, T. W. House, R. O. Love, A. Groesbeck, J. R. Morris, H. R. Allen, and their associates, be, and the same are hereby, created a body corporate and politic, under the name and style of the "Buffalo Bayou Ship Channel Company," with authority in said corporate name and capacity to contract; sue and be sued; to plead and be impleaded; to acquire real and personal property, by gift or purchase, and to sell, grant, mortgage, or alienate the same; to borrow money, and to issue its bonds with interest warrants attached thereto; to make by-laws for its own government; to have succession, and a common seal; and generally to do and perform all such acts and things as may be necessary to, proper for, or incidental to the carrying out of its obligations, the maintenance of its rights and privileges, and the accomplishment of the objects of the company in accordance with this act and not inconsistent with the constitution and laws of the State of Texas.

SEC. 2. That the said company are hereby authorized to form, construct, own, and maintain a ship-channel from any point at or within the corporate limits of the city of Houston, through Buffalo Bayou, deepening, straightening, and widening the same, and through the waters connecting said Buffalo Bayou with the Gulf of Mexico at Bolivar Channel, deepening and removing the obstructions thereof to the Gulf of Mexico at Bolivar Channel (including the construction of all locks, gates, or dams that may be requisite), so as to make said ship-channel of such continuous depth, width, and extent as may be essential for the purposes of foreign and domestic trade and commerce, and to build, own, and possess such ship-basins within or near the corporate limits of the city of Houston, in such numbers, depth, and capacity as may be requisite for the purposes of the company with all slips, wharves, docks, buildings, and machinery necessary or in anywise pertaining thereto; and the said company are furthermore authorized to build, construct, and possess such steam-boats, tug-boats, dredge-boats, barges, tools, machinery, and buildings, or any other property of any and every kind whatever, as may be necessary to, convenient for, or adapted to the prosecution, management, and accomplishment of this act and the purposes of foreign and domestic commerce.

SEC. 3. That said company, in order to accomplish the purposes above specified, are hereby empowered to perform such dredging and make such excavations, enlarge such streams and deepen such channels, cut off such bends, and remove such obstructions in Buffalo Bayou and the bays and waters connecting Buffalo Bayou with the Gulf of Mexico at Bolivar Channel as may seem desirable and necessary to build said ship-basins and construct said ship-channel; and it shall be lawful for said company to appropriate and use such lands in the several bayous, streams, gulfs, and waters, or on the banks thereof, or lying contiguous thereto, as may be requisite for the specific purposes of this act, making compensation to the several owners thereof as may be agreed upon by the parties and the company; and if unable to agree, then in accordance with the general railroad laws of the State, and as provided therein, whenever so using or appropriating said lands.

SEC. 4. That the capital stock of said company shall be $1,000,000 (including all its property, real and personal, franchises, and rights to property), to be divided into shares of $100 each, 5 per cent. to be paid at the time of subscription, and the remainder in installments of 5 per cent. as often as it may be called for, after giving thirty days' notice of said call in some newspaper published in the city of Houston. Such subscriptions, upon failure of payment thereof, may be enforced by said company in any court having jurisdiction in the State, or may be sold at public auction, after twenty days' public notice given, the delinquent being liable in the full amount for all deficiencies between the amount so received at the sale thereof and the unpaid balance on his subscription, and for all proper charges and interest thereof. Said shares of capital stock shall be deemed personal property, and shall be transferable under such rules and regulations as may be provided for in the by-laws of the company. Nevertheless, the board of directors shall have authority to dispose of the shares in its capital stock in such manner and on such terms as they may deem most conducive to the interest of the company and the fulfillment of the objects of this act, and shall be, furthermore, authorized to commence operation whenever five hundred shares shall have been taken.

Sec. 5. That the company may receive in payment for its shares or bonds the work of contractors done, hire of agents, laborers, and employés, materials or machinery furnished in constructing the enterprise, city or town lots, houses, land, and real or personal property of any kind whatever, bonds of the city of Houston, or any other corporate city or town, or of any county within the limits of the State; and such corporate city, or town, or county is hereby authorized to subscribe for said stock or bonds and to issue its bonds for the same. Said property so subscribed shall be at such valuation as may be determined upon between the parties and the company. Each share shall be entitled to one vote, either in person or by proxy, and all dividends shall be paid at the principal office in the city of Houston, but no dividend shall, at any time, be declared impairing the capital stock.

Sec. 6. That management of the said company shall be confided to a board of nine directors, to be elected annually by the stockholders. For the purposes of organization and commencement of the enterprise, the corporators named in the first section of this act shall constitute the first board of directors, to serve one year, or until their successors are duly elected. The board of directors, when duly constituted, shall elect their own officers at their first meeting, and shall have authority to fill any vacancies that may arise in the board from death, resignation or otherwise. During the intervals between the regular election by the stockholders, the said board (five of whom shall constitute a quorum) shall manage and control the business affairs and property of the company, and shall keep, or cause to be kept, full and accurate records of the transactions of the company, of all receipts and expenditures made, and of all property, real or personal, held, received, or transferred, and shall cause such records, or a synopsis of the same, to be submitted at each annual meeting of the stockholders.

Sec. 7. That whenever said company shall have made such ship-channel navigable through Red Fish Bar and Morgan's Point for vessels drawing 6 feet of water, it shall be authorized to impose and collect of all vessels passing through that portion of said channel cut through Morgan's Point, toll at the rate of 10 cents, each way, per ton measurement; and when said company shall have made such ship-channel navigable through Red Fish Bar and Morgan's Point for vessels drawing 8 feet of water, it shall be authorized to impose and collect of all vessels passing through that portion of said channel cut through Morgan's Point additional tolls at the rate of 10 cents, each way, per ton measurement of such vessels; and when said company shall have made said channel navigable from the Gulf of Mexico at Bolivar Channel to the city of Houston for vessels drawing 9 feet of water it shall have the right to impose and collect of all vessels passing through that portion of said channel, between Morgan's Point and the city of Houston, or stopping at any of the points of landing between Morgan's Point and the city of Houston, additional tolls at the rate of 10 cents, each way, per ton measurement, of such vessels passing through the channel, or any porton thereof, made by said company: *Provided*, That the whole amount of tolls upon vessels passing through the entire length of said channel from the Gulf of Mexico, at Bolivar Channel, to the city of Houston, shall never exceed 30 cents, each way, per ton measurement. And should the city of Houston cede, transfer, lease, or grant to said company its rights and privileges of imposing and collecting toll and wharfage of all vessels navigating Buffalo Bayou within its corporate limits, then said company are empowered hereby to impose and collect such rates of toll and wharfage as they may determine upon; the toll, however, not in any case to exceed in the whole amount, and including all toll collected, 40 cents, each way, per ton measurement of any vessel.

Sec. 8. That if any person or persons shall wilfully and maliciously obstruct, impair, or destroy said ship-channel or ship-basins, or any part thereof, or injure the property of the company, such person or persons so offending shall be punished, when presented by indictment of law, and shall also be liable to action for damages by said company, or any person or persons whatsoever that may suffer injury in person or property from said obstructions, and for full amount of damages that may be occasioned thereby.

Sec. 9. The organization of the "Buffalo Bayou Ship Channel Company" heretofore entered into at the city of Houston, in accordance with the terms of the aforesaid declaration of the convention, is hereby legalized; and all the acts and contracts of the company done and entered into, in accordance with the aforesaid declaration, are hereby declared to be of full force and effect; provided nothing herein contained shall be construed as making valid any land grant to said "Buffalo Bayou Ship Channel Company."

SEC. 10. That Eugene Pilot, H. E. Perkins, T. H. Scanlan, J. G. Tracy, E. W. Cave, J. W. McDonald, and Peter Gabel are hereby added and created the associate incorporators with those named in section 1, with the same duties, powers, and rights as those mentioned in this act,

SEC. 11. The franchise, rights, privileges and immunities herein granted shall continue to be enjoyed by said "Buffalo Bayou Ship Channel Company" for the period of fifty years from the 23d day of January, A. D. 1869.

SEC. 12. This act shall take effect and be in force from and after its passage.

Approved July 28, 1870.

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS.

Statement of freight carried by the Houston Direct Navigation Company during the fiscal year ending June 30, 1887.

Articles.	Quantity.	Approximate value.	Freight charges.
	Pounds.		
Cotton	74, 508, 500	$6, 741, 765	$74, 508. 50
Cotton-seed cake	16, 444, 620	16, 444	11, 511. 23
Railroad iron	2, 450, 640	30, 633	1, 715. 45
Oils	1, 637, 715	81, 855	1, 965. 25
Lumber	1, 073, 600	24, 150	858. 88
Salt	2, 078, 600	10, 393	1, 662. 88
Coal	9, 108, 960	24, 400	6, 376. 27
Castings	1, 849, 692	92, 485	2, 034. 66
Cotton ties	736, 740	14, 735	884. 09
Plaster	500, 000	6, 250	600. 00
Total	*110, 389, 067	7, 043, 110	102, 117. 21

* 55,195 tons.

T 5.

IMPROVEMENT OF THE MOUTH OF BRAZOS RIVER, TEXAS.

The work of construction was last suspended in December, 1884. It was not resumed during the year. It being understood that no useful results had been obtained from the old works, and that they were in a dilapidated condition, it was necessary; before proceeding to expend the appropriation of $18,750, contained in the river and harbor act of August 5, 1886, to make a resurvey of the locality, with a view to revising the project. Owing to a pressure of other work the survey could not be undertaken until late in May. The field-work was completed June 15. At the end of the year the map was in process of construction.

The results of the survey not being available for use, I have not been able to give the work the careful study which should precede an estimate of funds. I am sufficiently familiar with it, however, to be certain that the amounts estimated in the last annual report are not excessive.

I therefore renew the estimate of last year for continuing the work during the next fiscal year, viz, $100,000.

Commercial statistics for the year have been collected, and are herewith transmitted.

The original estimated cost of this work was	$522,890.44
Aggregate amount appropriated to July 1, 1887	158,750.00
Amount actually expended	140,833.94

The work is located in the collection district of Galveston. The nearest light-house is at the entrance to Galveston Harbor.

The amount of revenue collected at the port of Velasco, Tex., for the fiscal year ending June 30, 1887, was $———.

Money statement.

July 1, 1886, amount available	$168.53
Amount appropriated by act approved August 5, 1886	18,750.00
	18,918.53
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,002.47
July 1, 1887, amount available	17,916.06
Amount (estimated) required for completion of existing project	364,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS OF BRAZOS RIVER, TEXAS.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 23, 1887.

MAJOR: I have the honor to make the following report relating to the commerce of Brazos River:

In accordance with your written instructions of May 28, 1887, from which I make the following extract: "In connection with the survey of the mouth of Brazos River, you are requested to ascertain as far as practicable the amount of commerce which has used this entrance during the past year or during the calendar year 1886. The information desired is the number, size, draught, and character of the vessels which entered or left the river, the kind, amount, and value of the freight carried by them, and the amount of the freight charges," every source from which it was believed this information could be obtained has been consulted, and it is to be regretted that very little definite information could be obtained.

Such information as it was possible to get consists mainly of estimates made by people living and doing business on the river and those engaged in the transportation of freight.

Only coastwise vessels are engaged in this trade.

From the records of the custom-house at Galveston it is learned that for the fiscal year ending June 30, 1887, there were 49 schooners and 1 sloop, with an aggregate tonnage of 819 tons, arrived at Velasco, presumably via the mouth of the river. In addition to these, there is 1 steamer which makes regular trips between Galveston and Columbia during the winter months, via the canal, and there are also a number of smaller craft which enter the river by this route.

Mr. J. L. Hudgins, the canal keeper, estimates that of the number of vessels which enter the river more than 50 per cent. enter via the canal; but, on account of their smaller size, they carry something less than 50 per cent. of the freight.

The draught of vessels in this trade is limited by the depth of water on the bar and in the canal. The depth of water on the bar varies considerable from month to month. The maximum draught loaded of vessels which make regular trips by the outside route was 4½ feet. During the month of September no vessel was able to cross the bar. The depth of water in the canal is at present not over 3 feet, and I am informed that a rapid filling is taking place which, unless dredging be resorted to, will in the near future render the canal of but little value.

The kind, amount, and value of freight carried and the amount of freight charges is shown by the following estimates:

Estimate of Mr. A. Metcalfe, of Velasco, of the amount of produce shipped from Brazoria County for the year ending December 31, 1886.

Articles.	Quantity.	Freight charges.
Cotton .... bales..	5,000	$5,000
Cotton-seed .... tons..	1,500	4,500
Bones .... do....	1,000	5,000
Sugar .... hogsheads..	2,000	5,000
Molasses .... do....	4,000	3,200
Wood .... cords..	2,000	4,000
Total	....	26,700

In addition, $200,000 worth of general merchandise entered the river via Velasco, upon which the freight charges were, per barrel, 50 cents by steamer and 40 cents by sailing craft.

Estimate of Messrs. J. G. Smith & Bro., dealers in general merchandise, Columbia, of freight carried or that would be carried by boats navigating the Brazos River.

Articles.	Quantity.	Value.	Freight charges.
Cotton .... bales..	10,000	$400,000	$7,500
Cotton seed .... tons..	5,000	40,000	15,000
Sugar .... hogsheads..	1,000	40,000	3,000
Molasses .... barrels..	2,000	25,000	1,800
Total	....	505,000	27,300

The up freight would be at least double the above figures in value and freight charges.

Mr. George O. Jarvis, manager of a large sugar plantation on the river, estimates the annual sugar product at from 500 to 600 hogsheads. He also furnished the following list of freight charges:

Cotton, to Galveston	per bale..	$0.75
Cotton seed, to Galveston	per ton..	3.00
Sugar, to Galveston	per hogshead..	2.00
Molasses, to Galveston	per barrel..	.80
General merchandise, from Galveston	per cwt..	.30
Lumber, from Calcasieu to Columbia	per M..	7.00

Very respectfully, your obedient servant,

H. C. Ripley,
United States Assistant Engineer.

T 6.

IMPROVEMENT OF PASS CAVALLO, INLET TO MATAGORDA BAY, TEXAS.

The work of construction was last suspended in July, 1885. It was not resumed during the year. Upon assuming charge of it late in the autumn of 1886, I found that the engineering staff had been disbanded on account of the failure of the appropriation bill the year before, and that but little was known in this office as to the condition of the works or the results attained by them. It was understood that they were in a dilapidated condition. It was necessary before proceeding to expend the appropriation of $37,500, contained in the river and harbor act of August 5, 1886, to make a resurvey of the locality and a careful examination of the works with a view to revising the project. Owing to inclement weather and to a pressure of other work, the survey could not be undertaken until late in May. A party was dispatched from Galveston on the 30th of May, and reached the ground on the 7th of June. It is still in the field.

As in the case of Brazos River, it has not been possible to give the work the careful study which should precede an estimate of funds. It is altogether certain, however, that the estimates contained in the last annual report are not excessive. The jetty upon which the expenditures have been applied, was estimated to cost $760,100. About $290,000 has been expended, which is about 38 per cent. of the estimate, while not more than 14 per cent. of the work had been placed at the time of its suspension in July, 1885. I therefore renew the estimate of last year for continuing the work during the next fiscal year, viz; $200,000.

The town of Indianola, at which the custom-house was formerly located, the only town of any importance on Matagorda Bay, has been abandoned. It suffered so severely during the storm of 1875, and again during that of last August, that the inhabitants have concluded to seek a safer location. The custom-house has been removed to Eagle Pass, on the Rio Grande. No steamer has entered Matagorda Bay during the year. Small coastings schooners, drawing 5 feet or less, still visit Port Lavaca, upon Lavaca Bay, which communicates by shoal water with Matagorda Bay on the north. A statement showing the amount of this trade is hereto appended. The improvement of Pass Cavallo at this time is desirable rather as a port of refuge than as a highway of commerce. In the former capacity it will be of benefit to all of the coasting trade of Texas.

The original estimated cost of this work was	$1,039,280.00
The aggregate amount appropriated to July 1, 1887, is	327,500.00
The amount actually expended is	290,095.16

The work is located in the collection district of Saluria. The nearest light-house is upon Matagorda Island. There was no revenue collected at Indianola or Port Lavaca during the fiscal year ending June 30, 1887.

Money statement.

July 1, 1886, amount available		$2,034.88
Amount appropriated by act approved August 5, 1886		37,500.00
		39,534.88
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,138.78	
July 1, 1887, outstanding liabilities	991.26	
		2,130.04
July 1, 1887, amount available		37,404.84

Amount (estimated) required for completion of existing project	1,366,780.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Statement of vessels which entered and left Matagorda Bay, Texas, during the fiscal year ending June 30, 1887.

Name of vessel.	Draught.	Entered.				Left.			
		No. trips.	Cargo.	Value of cargo.	Amount of freight charges.	No. trips.	Cargo.	Value of cargo.	Amount of freight charges.
	Feet.								
Fair Play	5	1	Lumber	$405	$108	1	Empty		
Quintana	5½	2	do	1,260	336	2	do		
H. Judson	5	1	Fish	50		1	do		
Lake Austin	4½	15	General merchandise.	150,000	2,250	15	Hides, wool, cotton.	$7,500	$1,200
Tidal Wave	3½	2	do	10,000	300	2	do	1,000	100
Sea Gull	4	17	do	85,000	2,550	17	do	8,500	850
Nellie Sweeney	3⅓	11	do	55,000	1,650	11	do	5,500	550
Columbo	4½	15	do	150,000	2,250	15	do	7,500	1,200
Total		64		451,715	9,444	64		80,000	3,900

All the above were sailing vessels, schooner rigged.

T. D. WOODWARD,
Deputy Collector.

LAVACA, TEX., *July* 11, 1887.

T 7.

IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS.

Works for the improvement of this locality (see sketch Plate II) were begun in 1880, and were last suspended in April, 1885. Before the works were begun the pass was moving bodily in a southwestward direction, the southerly shore being eroded and the northerly shore advancing by accretion. The rate of movement between 1868 and 1878 was about 260 feet per year. The depth upon the bar in its natural state varied greatly. It was 9 feet in 1852 and 1853, 7½ feet in 1868, 9½ feet in 1871, 7 feet in 1875, and 7 feet, in 1878 all at mean low tide. The available harbor room within the bar also varied greatly. The area inclosed within the curve of 24 feet depth was 64.28 acres in 1868 and 96.87 acres in 1878. Mustang and Saint Joseph's islands, which bounded the pass, were composed of fine sand, and their surfaces were being eroded by wind, the material being swept into the channels. The works had for their object (1) to stop the southward movement of the pass and to fix its position; (2) to deepen the channel over the bar at the entrance to 12 feet; and (3) to stop the erosion of the bounding islands by wind.

In assuming charge of this improvement late in the autumn of 1886 I had reason to believe that the works constructed had not proved entirely successful. Before proceeding to the expenditure of the appropriation of August 5, 1886, it was necessary to make a resurvey of the locality and a careful examination of the works. Owing to the lateness of the season the survey had to be deferred until March. It was begun March 15 and the field work completed May 22. The results were forwarded with my report of June 22. They may be summarized as follows:

The works constructed to stop the southward movement of the pass, consisting of seven groins, a breakwater, and a revetment, have partially accomplished their object. The erosion of the shore has continued, but it has been very much slower than it was before. Instead of 260 feet per year, which was the rate before 1878, the rate has been, since the completion of the work in 1882, about 70 feet per year. They have suffered serious damage, and can not be relied upon to retard the erosion for any prolonged period. The great increase of the depth of the water at the places where they are located prohibits an attempt to restore them. A new protection must be placed in their rear, utilizing what remains of them as far as practicable.

The work designed to deepen the channel over the bar, consisting of a single jetty constructed upon the south side of the entrance, has had no important effect upon the bar and is in a dilapidated condition. The channel depth over the bar is now 8½ feet, and the channel crosses the jetty.

The works designed to stop the erosion of the surface of the islands by wind, consisting of sand-fences and plantations of salt cedars, have disappeared and left no trace behind them.

The plan of the improvement being in my judgment defective, I submitted in the report above referred to a new plan. It is shown in outline upon the accompanying sketch (Plate II). It is proposed to abandon so much of the old line of the south jetty as curves northwardly, and by an easy change of direction southwardly to conduct the jetty by the shortest line to deep water. A north jetty is proposed, which shall be parallel to the outer portion of the south jetty and 2,000 feet from it. Both jetties are to extend out to the 20-foot curve, to be 12 feet thick on top at their inner extremities, increasing to 24 feet thick at their sea ends, their crests to be 5 feet above mean low tide, and to be composed of teredo-proof material throughout, the foundations being simply a broad base of ordinary riprap. They are expected to secure and maintain a channel depth of not less than 20 feet. For the protection of the head of Mustang Island it is proposed to cover the slope from high-water mark out to the bottom of the channel, or near to it, with a continuous revetment of riprap about 18 inches thick. The latter work, being of the first necessity, will be undertaken first. It will require all of the funds now available. The cost of the new works is estimated to be $1,688,500.

During the fiscal year ending June 30, 1889, it is proposed to complete the protection of the head of Mustang Island, and to construct both jetties out to the 20-foot curve.

Commercial statistics are hereto appended:

The original estimated cost of this work, as here revised, is	$2,052,543.72
The aggregate amount appropriated to July 1, 1887, is	481,250.00
The amount actually expended is	383,618.02

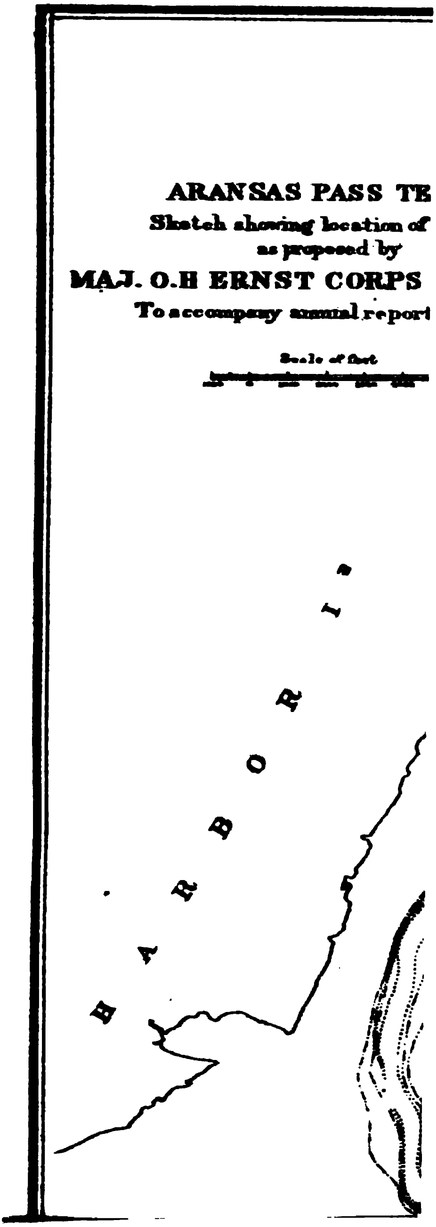
In addition to this there was expended the sum of $9,938.93, contributed by the citizens of Rockport and Corpus Christi.

The work is located in the collection district of Corpus Christi, Tex. The nearest light-house is upon Harbor Island.

The amount of revenue collected at the port of Corpus Christi during the fiscal year ending June 30, 1887, was $54,158.75.

Money statement.

July 1, 1886, amount available		$2,999.90
Amount appropriated by act approved August 5, 1886		101,250.00
		104,249.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,488.92	
July 1, 1887, outstanding liabilities	129.00	
		6,617.92
July 1, 1887, amount available		97,631.98



ARANSAS PASS TE
Sketch showing location of
as proposed by
MAJ. O.H ERNST CORPS
To accompany annual report

Scale of feet

Amount (estimated) required for completion of existing project	$1,571,293.72
Amount that can be profitably expended in fiscal year ending June 30, 1889	1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

STATEMENT SHOWING THE RECEIPTS AND SHIPMENTS OF GENERAL MERCHANDISE, LUMBER, ETC., AT THE PORTS OF CORPUS CHRISTI AND ROCKPORT, TEXAS, DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

[Furnished by Chas. F. Bailey, esq., collector of customs, Corpus Christi, Tex.]

CORPUS CHRISTI, TEX.

Amount of general merchandise received	pounds	16,071,089
Amount of general merchandise shipped	do	11,884,605
Amount of lumber received	feet	5,747,808
Number of steam vessels entered		23
Number of steam vessels cleared		23
Number of sail vessels entered		145
Number of sail vessels cleared		145

ROCKPORT, TEX.

Number of cattle shipped outward	head	4,003
Amount of merchandise shipped outward	pounds	412,000
Amount of fish and turtle shipped outward	do	140,000
Amount of merchandise received	do	2,234,000
Amount of lumber received	feet	222,000
Passengers, outward		78

Total amount of revenue collected in the district of Corpus Christi, Tex., $54,158.75.

No means of ascertaining the draught of vessels. The greatest depth, however, was 8½ feet.

No means of ascertaining the value of freight carried, nor the number of passengers.

Freight charges averaged about 25 cents per hundred.

T 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The work of construction here was last suspended in October, 1884. The results having proved unsatisfactory, the improvement was referred by the Chief of Engineers, under date of December 8, 1885, to the Board of Engineers for a report. The Board called for certain information which involved a resurvey of the harbor and other investigations. A party under the orders of First Lieut. George A. Zinn, Corps of Engineers, United States Army, left Galveston on the 24th of June, 1887, to procure the desired information. At the end of the year this work was in progress.

No careful estimate of funds can be prepared in advance of the report of the Board. It is certain, however, that the estimates contained in the last annual report are not excessive. That the work may not be left unprovided for, I renew the estimate of last year for continuing it during the next fiscal year, viz, $200,000.

Some commercial statistics of the port are hereto appended.

The original estimated cost of the work was	*$678,084.50
The aggregate amount appropriated to July 1, 1887, is	†222,500.00
The amount actually expended is	185,204.17

---

* Subject to revision.

† In addition there was appropriated in 1878 $6,000, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest light-house is the Brazos Santiago Light-House on Padre Island.

The amount of revenue collected at the port of Brownsville for the fiscal year ending June 30, 1887, was $32,515.78.

Money statement.

July 1, 1886, amount available		$336.28
Amount appropriated by act approved August 5, 1886		37,500.00
		37,836.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$265.96	
July 1, 1887, outstanding liabilities	274.49	
		540.45
July 1, 1887, amount available		37,295.83
Amount (estimated) required for completion of existing project		455,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEXAS.

CUSTOM-HOUSE, BROWNSVILLE, TEX.,
Collector's Office, July 25, 1887.

SIR: I have the honor to acknowledge the receipt of your letter of the 23d ultimo, asking for commercial statistics of this district for the last fiscal year, and would have answered same before but have been delayed by pressing official business.

The amount of revenue collected in this district of Brazos de Santiago during the fiscal year ending June 30, 1887, was $32,515.78.

There enters and clears about once every ten or twelve days during the year, a Morgan Line steamer of about 1,000 tons burden, at present the *Aransas*, of 678.73 tons; the following-named schooners in the lumber trade between this port and Calcasieu, La., chiefly the *George Locke*, *Catha Minerva*, *Leman No.* 3, *Henrietta*, *Lottie Mayo*, *Willie Ann*, *Tilly Ida*, and *Quintana*. They make frequent trips, say about sixty during the year, carry no passengers, and not being recorded in this district, tonnage can not be given. They bring here cargoes of lumber and generally take away cargoes of bones, sometimes with hay or brick, but not being required to enter or clear, the statistics can not be given. The light-house steamer *Pansy*, the Coast Survey schooner *A. Borden*, the French bark *Agricola*, of 311 tons, from Bordeaux, France, and the Mexican schooner *Bravo*, 26.79 tons, from Tampico, Mexico.

The French bark *Agricola* entered once during the year with an assorted cargo of wines, liquors, fancy groceries, etc., of the value of $14,000, and cleared in ballast for Tuxpan, Mexico. The schooner *Bravo* entered with 20 tons of fruit and corn from Tampico, Mexico, and cleared for same port in ballast. No passengers were brought by either of these vessels. All passengers are brought by the Morgan Line as a rule.

* * * * * * *

The other information requested in your letter we have no records of, and I am therefore unable to furnish.

I trust the foregoing may be of service to you.

Very respectfully,

J. J. COCKE,
Collector.

O. H. ERNST,
Major of Engineers.

T 9.

PROTECTION OF RIVER BANK AT FORT BROWN, TEXAS.

This work was suspended in January, 1881. In the annual report of 1882, it was stated that no further work by the Government was desirable. It was recommended that no further appropriation be made, and none has been made since or recommended to be made. During the last fiscal year $3.54 has been expended in the stationery, and clerical labor involved in making the regular monthly and annual reports, leaving the balance now remaining unexpended $1,000. As Congress appears to have abandoned the work, I was authorized by your letter of June 30, 1887, to drop it from the list of those under my charge. The record is closed with this report.

Money statement.

July 1, 1886, amount available	$1,003.54
July 1, 1887, amount available	1,000.00

T 10.

PRELIMINARY EXAMINATION OF CEDAR BAYOU, TEXAS, WHERE IT EMPTIES INTO GALVESTON BAY.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 10, 1887.

GENERAL: The river and harbor act of August 5, 1886, provided for the survey or examination of "Cedar Bayou, where it empties into Galveston Bay," if, after a preliminary examination by a local engineer, the stream should, in the opinion of the Chief of Engineers, be worthy of improvement by the General Government.

By your letter of September 27, 1886, this preliminary examination was assigned to Major Mansfield, and it has since fallen to me as his successor in charge of this office. I am required to state whether, in my opinion, the stream is worthy of improvement, with reasons.

Under the river and harbor act, approved June 23, 1874, a survey of this locality was made in November, 1874, under the direction of Capt. C. W. Howell, whose report may be found in the Annual Report of the Chief of Engineers for 1875, page 941.

Captain Howell estimated that it would cost $5,750 to excavate a channel 100 wide and 5 feet deep through the bar at the mouth of the bayou, and he thought that the commerce of the stream was sufficient to justify that expenditure. He thought that subsequent dredging would be required from time to time to maintain the channel, but for this he made no estimate.

Since the date of Captain Howell's report much dredging has been done in Galveston Bay, and comparative surveys have furnished data for estimating the degree of permanency of such work. A channel was dredged by the Buffalo Bayou Ship-Channel Company in 1875-'76 for a distance of about 5 miles out into the bay from Morgan's Point, the width of the cut being from 120 to 150 feet, and the depth of excavation being nowhere less than 6½ feet. An examination in 1883 of the lower end of this cut showed that so far as the examination extended it had been entirely obliterated.

Between May, 1879, and May, 1880, a channel 100 feet wide and 12 feet deep at mean low tide was cut by the Government from Bolivar Channel to Redfish Bar a distance of 9½ miles, the average depth of the excavation being about 4 feet, and the amount of material removed being 703,646 cubic yards. In October, 1882, there had been a fill of about 543,000 cubic yards, or 77 per cent. of the amount excavated. The average depth of the fill was 2.91 feet, which is 73 per cent. of the average depth of the cut. (See Annual Report of the Chief of Engineers for 1883, pp. 1079, 1080). That is, in 2⅓ years about three-quarters of the work had been undone by natural causes.

It is reasonable to suppose that the rate of deterioration would be more rapid during the first year than during the second, and it is therefore favorable to the easy maintenance of the channel to assume that the rate was uniform during the 2⅓ years. Even with this assumption it appears that the amount of fill was over 30 per cent. per year of the amount of excavation.

There is nothing about the bar at the mouth of Cedar Bayou which gives reason to expect greater permanency in an excavation made there than in one made elsewhere in Galveston Bay. On the contrary, the direction of the flow of San Jacinto River would indicate that a more rapid fill might be expected there than elsewhere. It is rather an underestimate therefore to assume that, whatever amount may be required to excavate the channel, at least 30 per cent. of that amount will be required annually to maintain it.

I am not able without a new survey to verify the estimate made by Captain Howell in 1874, but it is probable that that estimate, $5,750, is not very far from what the work would now cost. Thirty per cent. of $5,750 is $1,725, which may be taken as the annual cost of maintenance. This sum capitalized at 4 per cent. is $43,125. Adding this to the original cost of the work, we find its total cost to be $48,875, instead of $5,750; or, reversing the process and adding the interest on the original cost—4 per cent. on $5,750=$230—to the actual cost of maintenance, we have an annual outlay of $1,955 as the amount required to construct and maintain the proposed improved channel.

This is the measure of the benefit that those who use the channel must derive annually from its improvement to make the work expedient.

In a letter to this office dated December 20, 1886, from Mr. J. P. Davie, of Galveston, Tex., the commerce of Cedar Bayou for the first eleven months of 1886 is stated to be as follows:

Transported from the Bayou to Galveston:	
Bricks, 602,304, valued at	$60,000
Cotton, 300 bales, valued at	15,000
Wood, 1,000 cords, valued at	5,000
Charcoal, 5,000 bushels, valued at	2,500
Cattle, hogs, fowls, and eggs, valued at	2,000
	84,500
Transported to the Bayou from Galveston:	
General merchandise, valued at	90,000
Total	174,500

In addition to this there is some trade to Buffalo Bayou, Trinity River, and the coast of Texas and Louisiana, which would swell the amount, he thinks, to about $200,000 per year.

The freight rates are given by Messrs. Milan & Bro., of Galveston, as follows:

Bricks, 6,023, at $2	$12,046
Cotton, 300 bales, at 75 cents	225
Wood, 1,000 cords, at $2	2,000
Charcoal, 5,000 bushels, at 5 cents	250
Cattle, hogs, fowls, and eggs, approximately	250
General merchandise, say 18,000 barrels, at 25 cents, approximately	4,500
Total freight charges upon a trade of $174,500	19,271
Freight charges upon a trade of 200,000, say	22,000

Boats are now loaded to about 3½ feet draught. With an improved channel over the bar they could load to 4½ feet draught, and could carry about one-third more freight. The cost of transportation would be reduced, though not in the proportion of one-third, since the loading and unloading, which forms a large part of the expense of transportation, would remain the same, and since it would often happen that full loads would not present themselves, a saving of 10 per cent. might perhaps be expected. This would amount to about $2,200 per year, and as the annual expense of the work would be but $1,955, the improvement would seem to be a good investment for those engaged in the freighting. They would hardly be able to reduce the freight charges if they paid for the work, but they would have a small additional profit from their business.

The question, is the stream worthy of improvement, as a bare proposition, is therefore answered in the affirmative.

* * * * * * *

I think it proper, when stating that Cedar Bayou is worthy of improvement, to state at the same time that I do not recommend its improvement by the General Government.

Very respectfully, your obedient servant,

O. H. Ernst,
Major of Engineers.

Brig. Gen. Jas. C. Duane,
Chief of Engineers, U. S. A.

APPENDIX U.

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPTAIN JOSEPH H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Cane River, Louisiana.
3. Survey of Bayou Pierre, Louisiana.
4. Cypress Bayou, Texas and Louisiana.
5. Loggy Bayou, Lake Bistenau, and the Dorcheat, Louisiana.
6. Ouachita and Black Rivers, Arkansas and Louisiana.
7. Bayou D'Arbonne, Louisiana.
8. Bayou Bartholomew, Louisiana and Arkansas.
9. Bayou Boeuf, Louisiana.
10. Tensas River and Bayou Macon, Louisiana.
11. Big Black River, Mississippi.
12. Yazoo River, Mississippi.
13. Tchula Lake, Mississippi.
14. Yallabusha River, Mississippi.
15. Tallahatchee River, Mississippi.
16. Steele's Bayou, Mississippi.
17. Big Sunflower River, Mississippi.
18. Big Hatchie River, Tennessee.
19. South Forked Deer River, Tennessee.
20. Water-gauges on the Mississippi River and its principal tributaries.

EXAMINATIONS.

21. Ouachita River, Louisiana, from Camden to mouth, with a slackwater navigation.
22. Cornay River, Louisiana.
23. Dugdemona River, Louisiana.
24. The lakes connecting with Red River between Shreveport, La., and Fulton, Ark. Also Clear Lake, Black Bayou, Red Bayou, Black Lake, and Kelly Bayou, to re-open navigable communication between those streams and Red River, Louisiana.
25. Cypress Bayou, Louisiana.
26. North Fork of Forked Deer River below Dyersburgh, Tennessee.
27. Ouachita River, above Camden, Arkansas.
28. Cassity Bayou, Mississippi.
29. Bayous Rondeway and Vidal, Louisiana.
30. Little River, Louisiana.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., September 19, 1887.

SIR: I have the honor to transmit herewith annual report for the fiscal year ending June 30, 1887, for works of river improvement and of examinations and surveys under my charge.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

The average monthly expenses of this boat when in commission are as follows:

Pay-roll	$1,500
Subsistence	350
Fuel, oil, and waste	250
Minor repairs, tackle, etc	150
Total	2,250

It costs about $150 a month to take care of her if laid up with others in the fleet, and about $250 if laid up alone.

The estimates for the year are as follows:

Nine months, at $2,250	$20,250
Three months, at $250	750
Special repairs now required	2,000
Extraordinary repairs, maintenance of outfit, and tackle	3,000
Total	26,000

The snag-boat *John R. Meigs*, P. R. Starr master, was temporarily withdrawn from Yazoo River on account of high water, and put to work in Red River, commencing operations February 4, 1887, which were continued until March 8, 1887, when, the water having reached too high a stage in Red River for continuing effective work, she was ordered to Yallabusha River, Mississippi. This boat began operations at the mouth, working up-stream, but, on account of backwater from the Mississippi causing a high stage in the lower river, but little was done below Alexandria, which point was reached February 7. Between Alexandria and Campti most effective work was performed, as shown by the following list of obstructions removed in but little more than a month's time:

	Number.
Snags pulled	452
Stumps pulled	104
Shore-snags cut	461
Side jams removed	2
Leaning trees cut	447

After suspension of operations in Ouachita River the snag-boat *O. G. Wagner*, E. F. White master, was transferred to work in this stream. She left Shreveport March 24, 1887, for Upper Red River, between Gilmer, La., and Garland, Ark., to remove obstructions too heavy for the smaller boat *Florence*, and in many places it was found necessary to remove the snags to allow the *Wagner* to proceed up-stream.

Work was continued until April 11, when the boat was returned to Shreveport and laid up at that point, after having removed the following obstructions:

	Number.
Snags pulled	202
Shore-snags cut	260

From the above it will be seen that the operations of these four snag-boats extended over almost the entire portion of Red River within this district; the *Florence* and *Wagner* having worked above Shreveport to Garland, Ark., and the *Howell* and *Meigs* below Shreveport to the mouth of Atchafalaya. The season generally was exceptionally favorable, and the work of the past year has resulted in freeing the channel of the most dangerous obstructions between Garland and the mouth of Atchafalaya.

Near Shady Side, about 15 miles above Shreveport, there remains an old and dangerous collection of obstructions, known as the "Dawn

Stumps," which will be removed by means of explosives as soon as the water reaches a favorable stage. The river is now probably freer of obstructions than it has been for years, but a vast amount of work still remains to be done towards improving navigation at medium and low stages, and, as heretofore stated, additional obstructions are continually forming.

The work thus far performed has had the effect of reducing insurance on property shipped by river, and also of lowering freight rates at competing points and along the banks of the river, besides improving the navigation, diminishing the risks thereof, and shortening time of delivery of products and supplies. The country bordering the river is fertile, and as the improvement advances it will be correspondingly developed and commerce and navigation probably largely increased.

In order to hasten this result a more powerful boat should be constructed, with improved machinery, so arranged as to be convertible into a dredge with grapple or clam shell in a few hours. The outfit should be increased by the addition of a powerful pressure pump, for washing snags and wrecks, thus saving useless strains of the hoisting machinery, and for grading banks in the sharp bends.

A centrifugal pump driven by independent engines should be used for cutting through the bars, such as exist at the bridge at Shreveport, at the mouth of Red River, and at the Rapions. Such a boat is very much needed for general service in the district, for work on wrecks that are too heavy for the appliances now in use. The cost will approximate very closely to the following:

Steel hull	$23,000
Boilers, main engine and shaft, heater, and feed-pump	13,000
Donkey engine and pump	1,200
Deck pump	200
Pressure pump	500
Centrifugal pump and engine	2,600
"A" frame for grapple and dredge	500
Main hoisting-engines	14,000
Steam capstans	2,500
Upper works, cabins, etc	3,500
Chains, cables, blocks, rigging, and tools	2,000
Outfit for cabins, officers and crew	2,000
Total	65,000

It will take at least nine months to complete and equip this boat, and probably one month will be required to adjust the working parts and deliver the boat in Red River. A further sum should therefore be allowed to cover the expenses of plans and inspection of material and work during construction, and for practical tests of machinery, readjustment, etc., and for delivering the boat at the scene of operations, and for this is estimated $5,000.

In addition to snagging operations and patroling the river when drift is running, the systematic clearing of the banks of brush, leaning trees, and projecting logs, the remains of old raft, should be undertaken.

The work ought to begin at Fulton, Ark., and be carried downstream, cleaning up everything by the way, and devoting especial attention to the bends. Such work is most easily done during extreme low water, when the depth is too little for snag-boats, and therefore a special boat should be built for the purpose. The cheapest plan would be to build a strong flat-boat with quarters for a chopping party of eighteen to twenty men, with overseer, watchman, and cook, The boat should be fitted with boiler, pump, steam capstans, and light shears or crane, for pulling logs out of the banks as they cave, and removing logs and small snags from the channel. The amount of work of this kind is so great, and the benefit that would result so immediate, that I recommend outfit and equipment for two parties. By such means a large amount of work can be done in one season, and so thoroughly as not to need doing over for many years. There will remain plenty of work of the same kind to employ the boats below Shreveport till they are worn out. The estimates for a single boat and party are as follows:

Boat and equipment	$4,600
Crew, subsistence, explosives, etc., 8 months, at $1,200	9,600
4 months' care at fleet, at $50	200
Repairs and maintenance of outfit, tackle and tools, fuel, etc	600
Total first year	15,000

Wear and tear in this kind of work is very great, so that the item for repair should be at least double for the second year.

To hasten the work below Shreveport, I recommend a light-draught iron or steel steamboat, with light shears or crane and steam capstans, and with quarters only for crew necessary to run the boat as a tender, the laborers to be quartered and fed on a plain flat-boat, inexpensively housed in. The estimates are as follows:

Steamer and outfit	$15,000
Quarter-boat and outfit	1,200
Tools, blocks, and tackle	800
Expenses of steamer, wages, subsistence, fuel, etc., for a year	6,000
Wages of chopping party, subsistence, explosives, etc	10,000
Total for first year	33,000

This tender will be very useful in delivering supplies to the larger boats, assisting in the survey now in progress, and in making examinations of the river and tributaries. When not specially required for Red River, it can be used on the small streams in that portion of the district for which plant has now to be hired.

In March, 1887, I sent out circular letters to persons interested in this river, asking for information about wrecks, their position, and the amount of obstruction.

Four lists were sent in, giving the names of boats, the cause of loss, and specifying those that are still serious obstructions.

Comparing these lists, I find that in fifty years 186 steamboats have been lost in Red River.

One list gives 86 snagged, 21 burnt, 11 destroyed during war, 4 exploded, and 3 destroyed by collision. Four are reported as more or less in the channel above Shreveport, 11 as badly in the way between Shreveport and Loggy Bayou, a distance of about 100 miles, and 18 as more or less in the channel below Loggy Bayou to the mouth of the river.

The most dangerous should be removed first, but any wrecks that tend to cause shoals and eddies should be destroyed. If high explosives are used liberally, the work should not be difficult or expensive. No special estimate is made for it, as it falls in the regular work of the boats.

ALEXANDRIA HARBOR.

A resurvey of the stretch of river for a considerable distance above and below Alexandria, La., was made in December, 1886, by Assistant

Engineer Neville B. Craig. A tracing of the map, which is on a large scale ($\frac{1}{2000}$) and is very complete, is sent herewith.

The caving on the Alexandria front, which caused so much anxiety to the property owners, has not increased. It is impossible to say whether this is due to the fact that the river remained low for the greater part of last season, and that no extraordinary high water followed, or that the caving had about reached its natural limit.

No further work should be recommended at Alexandria until the completion of the survey from Fulton, Ark., to the mouth, unless it should be found necessary to straighten and widen the dredge-cuts through the upper falls, the passage of which is now somewhat difficult at extreme low water, on account of the deflection at the middle. A few points remain below Bailey's Dam that might be reduced with advantage; but on the whole the present channel does very well, except in extreme low water, and will accommodate boats that can now cross the bar above Red River Landing.

Should dredging operations be resumed, the material can be used in continuing the training-wall on the right bank and in gradually filling on the old dam opposite, raising it shoreward to join the bank with a good riprap protection to high water to prevent flanking. The United States dredge, the *Lone Star*, after finishing the work in Cypress Bayou, could be most usefully employed on this and other work in Red River. As the dredge has been rebuilt from the appropriation for Cypress Bayou, a fair sum should be charged to Red River for use or transfer of plant.

With this condition, the estimate for four months' work on the upper and lower falls, including the building of two scows, a liberal supply of explosives, and towing and returning with dredge to the fleet at Shreveport, is $5,000.

The dredge was built originally for the work on which it is now engaged.

This is the second time it has been rebuilt at the expense of the appropriation for that work, although it had been used quite as much in Red River as in the route from Jefferson to Shreveport. The estimated value of the dredge when fully completed is $15,000, although a new one could not be constructed for that sum; therefore one-half, or $7,500, would not be an excessive charge upon the appropriation for Red River.

The map referred to has a special value in furnishing very full information which may be needed shortly in fixing the location of the railway and wagon bridge across Red River, authorized by the act approved March 3, 1887. (Public, No. 147.) As the act provides that the bridge shall not be commenced until plans shall have been approved by the Secretary of War, and that unless it be commenced within two years, or before March, 1889, it shall not be built, it is not too soon to make suggestions as to site, length of spans, etc.

The bridge should cross the river below Alexandria, at right angles to the line of channel. The draw-openings should not be less than 150 feet in the clear, the draw pier being placed so as to give passage either side at low water, and the draw should swing either way. If the length of 250 feet is the least chosen for fixed spans, the bridge can be placed so that but one long one would be required, giving one draw-pier and one channel-pier towards the middle of the river, and one channel-pier on each side near the banks.

Finally, the lowest part of the superstructure should be not less than 5 feet above highest known flood, to insure the free passage of drift. The width of draw-openings is the least that should be allowed, to provide for large boats and for towing, which is practiced to some extent and will doubtless be increased very much in a few years. Before locating the bridge or accepting dimensions, the interests of navigation should be consulted, not only in a general way, but by means of a public hearing, and a fair compromise made between the parties in interest.

SHREVEPORT BRIDGE.

The bar on the left bank, referred to in the last report, and in special report, June 18, 1886, increased very rapidly, and finally entered the draw-openings and practically suspended navigation for large boats at any stage below 5 feet.

A full report will be found in Ex. Doc. 198, House of Representatives, Forty-ninth Congress, second session.

Authority was obtained to make another survey in low water, but before it could be undertaken the river rose and has remained too high to permit the work to be done.

It is not probable that the survey can be made to advantage, or for a reasonable sum, until August or September.

The passage at Garland City is filling up in a similar manner, and a survey will be made of that section by the same party, and possibly of the railroad bridge at Fulton.

The results will be given in a separate report.

SURVEY OF RED RIVER.

The act of August 5, 1886, provided $25,000 for the thorough survey of this river from Fulton, Ark., to Atchafalaya River.

The original estimate of $45,000 contemplated beginning the work early in the season and carrying it through on a single appropriation. These conditions did not exist, and the item was further reduced by provision for work on Bayou Pierre.

Assistant Engineer Hart Vance was put in charge of the work, and to him, and the assistants I was fortunate in obtaining, the rapid progress of the work is due.

There being every reason to expect a further appropriation, I kept the parties in the field till March 3, 1887, and as a result the field-work has been carried through from Fulton to Shreveport, and a portion below Shreveport has been partly completed and the remainder of Bayou Pierre put in shape to be connected with the survey of the main river. The season was unusually favorable to outdoor work, though somewhat cold for the latitude, there being but little rain and the river low.

The parties were so well organized and trained to their duties that had there been a new appropriation the whole distance from Shreveport to Atchafalaya River would probably have been completed this year, and for the amount of the estimate. The cost now will be considerably increased. The plant will require overhauling; men engaged and discharged until the right kind are obtained, and a considerable time lost in working them into practice of adopted methods.

The expenses of the survey have been kept low thus far by the use of instruments transferred from the Engineer depot and borrowed from the Mississippi River Commission. Those obtained from the latter can not be counted on for another season. The permanent bench-marks and monuments must be put in above Shreveport before starting below, and thereafter put in as the work progresses.

They were omitted last season in order to apply the funds to carrying the work of the survey through to Shreveport, and have sufficient funds remaining for working up the notes in case there should be no further appropriation. The rates of pay must be raised, in order to induce good men to run the risk of fevers and disease, and a greater allowance must be made for subsistence, in order to keep the men in good condition.

Having gone over a good part of the route above Shreveport and some 40 miles of river below, and compared the work required with that of other surveys, I find that it will be necessary to increase the estimates, which, it must be remembered, were for continuous work, to $35,000. This sum is for field-work, preparations of field maps on scale $\frac{1}{10000}$, reducing and printing charts on scale for convenient use and for issue, and for permanent monuments.

The estimates are classified as follows:

Repair and refitting plant and outfits	$1,000
Instruments and repairs	1,200
Permanent monuments	4,000
Draughtsmen's stationery and supplies	500
Six months' field operations	18,000
Six months' office-work	5,700
Skilled draughtsmen	1,600
Reducing and publishing maps	3,000
Total	$35,000

For methods, progress, and estimates of work to be done, I give below extracts from the report of Assistant Engineer Hart Vance, who was in immediate charge of the work. Mr. Vance was well equipped for this service, having had a wide experience on the surveys of the Upper Missouri and Mississippi rivers.

Operations: Assistant Engineer F. S. Burrowes was selected as chief of party to conduct the survey of Bayou Pierre; and on September 8, he left Shreveport with a party of twenty-two men, all told, and such an outfit as could be made up from the stock on hand and purchase at that place.

Another party was formed under Assistant Engineer N. B. Craig for the purpose of so supplementing the survey made in 1884 of Red River, between Shreveport and Caspiana Landing, that it would be available as part of the general survey. This party commenced work at Shreveport September 10.

Gauges were established at the head of Tone's Bayou and at the head and foot of raft in Bayou Pierre, the office having already a gauge at Shreveport.

It was projected to build at once two quarter-boats, one for a party to begin the survey at Fulton, the second for another party to continue it below Caspiana Landing, upon the completion of the works mentioned above.

The difficulties encountered in procuring materials and carpenters, however, made it impracticable to get at this work before October 19, when quarter-boat No. 1 was commenced at Fulton. On October 25 the survey of Bayou Pierre to its final outlet at Bayou Winsey was completed, and on November 1 Mr. Burrowes, with his full party, began the work at Fulton. Additional gauges were now established at Fulton, Garland, and Collin's Bluff (mouth of Sulphur River), Ark.

Assistant Engineer Craig carried his work to Caspiana Landing, and thence to a connection with Mr. Burrowes's lines on Bayou Pierre; and on October 31 his party was disbanded at Shreveport, he being retained in the office to arrange his notes until November 10.

During November, the quarter-boat not being ready for occupancy, Mr. Burrowes's party had only the camp outfit provided for the warm weather of September and October, and in consequence they suffered much hardships—part of November being very inclement.

Though they worked with undiminished alacrity, their progress was unavoidably somewhat retarded.

Quarter-boat No. 1 was put to use December 1, and thenceforth this part of the work progressed without special drawbacks, except that in January, when the party was out of reach of towns or means of transportation, six laborers were disabled, at once, by measles.

Work on the second quarter-boat was prosecuted at such rate as the necessary materials could be obtained. This was so slow, however, that the boat was not entirely finished until about March 1.

On January 22 a gauging party, under Recorder E. L. Harman, was established at Tone's Bayou, it being intended to make a series of observations in Tone's Bayou and in Red River above and below, to determine the comparative discharge at all stages of the water. Until March 1, however, they were obliged to work with improvised means, a battery, necessary in operating the current meters, and for which requisition had been made January 14, not being delivered until February 28, only a week before disbandment was ordered. The results, therefore, though the stages of the river were exceptionally favorable for the project, are very unsatisfactory.

Mr. Burrowes reached Shreveport February 18, and next day reduced his party, retaining only his principal assistants and men enough to attend one transit-man in the field. Until March 1 these were engaged in completing the collateral work about Shreveport and digesting the notes of the survey.

Upon assurance of the failure of the river and harbor bill, all but Assistant Engineer Burrowes were discharged. The Tone's Bayou party was disbanded March 10, and all the gauge-keepers were discharged within the same week.

In the office about half the supplementary survey of Bayou Pierre has been mapped in pencil, and all the notes of the season's work in my charge, except those of the Tone's Bayou hydrographical observations, have been thoroughly digested.

Mr. Burrowes resigned his position May 24 to accept a chargé in Maine.

Methods: The following quotations from instructions to chiefs of parties will indicate the character of the survey:

"At intervals of not more than 20 miles, the true meridian will be ascertained by simultaneous observations with two or more instruments on one of the circumpolar stars at elongation, and all courses will be referred to this (the needle being used only to check readings). The basis of all trigonometrical work will be a system of triangles, wherever the character of the ground will admit of the ready establishment of such, and a carefully twice-measured transit and chain line where triangulation is impracticable.*

"A close stadia survey of the river proper will be made, and connected as often as practicable with the triangles or chain line. All marked features, abrupt points, sand-bars, channel snags, beginnings and endings of erosion, etc., will be instrumentally located and cross sections of the river bed and banks will be taken at intervals of not more than four times the width of the stream.

"Such a survey of the adjacent topography will be made as will afford data for a complete map covering not less than 2,000 feet on either side of the river. All important features, such as plantation-houses, gin-houses, line fences, limits of woodlands, streams, lakes, inland banks, etc., will be located, and the names and boundaries of plantations as far as ascertainable will be noted.

"At least once within every 2 miles, one of the river-bed cross sections will be extended at least 2,000 feet from each bank.

"Important tributaries and outlets will be surveyed for at least 2 miles from the main river.

All practicable connections with land surveys will be made.

A continuous line of levels will be run independently by two levelmen, with limits of error as to local discrepancy of 0′.005, and as to accumulated difference, of 0′.250.

"All collateral levels will be referred to this line.

"The line, and all sights between a transit station and the next, will be *plotted* to a scale of $\frac{1}{5000}$ on the page opposite the notes of the station, and on this plot a sketch of the space will be made *in view of the ground.*"

Limits of allowable error were set as follows:

In comparisons of deduced with astronomical courses (after correction for longitude), 2′; in courses of topographical transit lines, 6′, or an aggregate of 15″ per sight; in sums of observed angles of triangles, 20″; in comparisons with lines of verification, 0′.005; in topographical lines, 0.001 of distance run, or an aggregate of 20′ at a connection; and in levels, as stated, 0′.005 on any point (after compensation of unequalities of sight), or an accumulated difference (*ab initio*) of 0′.250. Any excess of these necessitated repetition and correction of the work. As indicated by the rate of progress, such repetitions were seldom required.

"The practical object of the work," it was stated generally, "is to locate 1-foot contours below the low-water slope, the crests, and 3-foot contours of the banks, and all topography within 2,000 feet of the river; to determine profiles of low and high water, the banks, and cross-sections of tributaries and outlets; to locate and describe all obstacles to navigation, and to furnish all such descriptions of soil, banks, and bottom as may be relevant to future questions of improvement."

Results: A thoroughly good survey of Bayou Pierre has been completed. The data, however, are not as yet so developed that the required reports as to advisability and cost of proposed improvement can be made.

The work between Shreveport and Caspiana Landing has scarcely any immediate value; essential connections with the survey of 1884, which it was meant to supplement, not having been made as directed. The subassistants have taken some excellent topography, however, which may be put to use when it is practicable to make the required connections.

The survey from Fulton, Ark., to Shreveport, La., has not been mapped, but I have made such a study of the notes as enables me to submit the following report:

Red River, between Fulton and Long Prairie, Ark., 88.07 miles, has a minimum width between banks of 600 feet (the mean width somewhat diminishing towards the lower point), and at ordinary low water a minimum channel width of 200 feet, a minimum depth, except at two places, of 6 feet, a mean slope of 0.375 foot per mile, and banks from 24 to 31 feet high (diminishing down-stream), with numerous points of hard clay left jutting into the stream where erosion has taken place. The adjacent land is almost entirely in cultivation.

---

* Triangulation was found to be inexpedient.

At the two points excepted, 23.6 miles below Fulton (2 miles above Dooley's Ferry) and 14.5 miles below Garland, respectively, the depth at ordinary low water (possibly 1.5 feet greater than at extreme low water) is only 3.5 feet.

Between Long Prairie and the mouth of Sulphur River, 19.32 miles, the width between banks is gradually diminished, while the water-width at low water is increased. The mean slope is 0.232 foot per mile, and the minimum depth 9 feet. The other characteristics are about the same as above.

Below Sulphur River the character of the stream changes greatly. The river-bed narrows rapidly, sand-bars are few, the banks grow lower and lower and keep close along the stream, and the water-width is only 175 to 200 feet. The slope from Sulphur River to the site of the head of old raft, 15.72 miles, is 0.130 foot per mile, and the minimum depth 9 feet. The banks are heavily timbered and habitations infrequent. In this reach occurs Sale and Murphy's Canal, the lowest point in the cross section of which is 3 feet above ordinary low water.

From the head of old raft to Cottonwood Bayou (4 miles below the end of raft), a distance of 35.80 miles, the width between banks seldom exceeds 300 feet, and is generally about 250 feet, the banks being steep and always near the water's edge, and showing, wherever they are broken, the old raft formation.

The mean slope is 0.306 foot per mile, and the minimum depth (except at one point, where it is 12 feet) is 15 feet.

From the Sale and Murphy's Canal (1 mile above head of raft) to Red Bayou, 15.15 miles, the adjacent land is wholly uninhabited; from Red Bayou to Gilmer, 6.44 miles, it is sparsely settled; and thence to Cottonwood Bayou it is cleared and cultivated on both sides, bluffs touching the river frequently on the left and an almost continuous levee following the right.

Above Gilmer, in this reach, there are numerous high-water outlets tributary to extensive lakes, most of which were originally artificial steamboat channels used during the existence of the raft. Below Gilmer there are only two outlets that remain unclosed, viz, Dooley's Bayou and Cottonwood Bayou. The bottom of the former is a foot and a half above ordinary low water. The bottom of the latter is 11 feet below ordinary low water and only 5 feet above the river bottom at its head. Its cross section is almost equal to that of the river below and seems to be increasing. This outlet was surveyed 3½ miles and found to separate into four smaller streams, after a fall of 6 feet from its head.

From Cottonwood Bayou to Twelve Mile Bayou, 29.16 miles, the width between banks is seldom more than 200 feet, and at its minimum is only 130 feet. For 9.66 miles the slope is 0.681 foot, then for 19.50 miles 1.345 feet per mile. At Pandora (7.58 miles above Shreveport) and at a point 2 miles above the depth is only 7 feet; elsewhere it is not less than 12 feet.

The subjoined table shows, together with the relative bank heights, the means along chords approximating very nearly the curves of actual slope, from Fulton, Ark., to Shreveport, La.

Distances from point to point.	To what point.	Height of bank above ordinary low water.	Height of bank above uniform slope.*	Fall.	Slope per mile.
Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
62.0	4.5 miles below Garland bridge	31 to 26 (diminishing).	30 (mean)	24.38	0.393
15.0		26 to 23 (diminishing).	29 (mean)	5.29	0.353
28.0	2.3 miles above Sulphur River	24 (mean)	30 (mean)	7.59	0.271
15.0	1.0 mile below Louisiana and Arkansas line.	23 (mean)	35 (mean)	1.44	0.096
23.5	Gilmer	19 (mean)	35 (mean)	6.81	0.290
13.5	1.7 miles above Cottonwood Bayou	17½ to 12 (diminishing).	36 to 31 (diminishing).	4.34	0.321
11.5	1.3 miles below Cat Island Cut-off	11 (mean)	29 (mean)	7.29	0.634
17.0		15 to 33 (increasing).	33 (mean)	24.86	1.462
3.9	Shreveport Bridge	34 (mean)	34 (mean)	2.10	0.539
†189.4				84.10	0.444

* From Fulton to Shreveport.

† Distances are measured along in intermediate parallel of the banks. Along the channel line they would probably be 5 or 6 per cent. greater.

It will be seen from this that at its culmination (just at the lower end of the raft site) the actual elevation of low water is 20 feet above a line of uniform slope between the extreme points.

The bank heights, on the other hand, except where they have been increased about 5 feet through the raft region, keep almost exactly parallel with the ideal slope.

It is evident that, to a great extent, the effect of the raft is as yet unremoved, that the normal slope would be practicably uniform, and that the river is in condition to be made a potent factor of its own correction.

At Fulton, at Garland, and at Shreveport the river is spanned by iron railway bridges. At Shreveport the channel through the draw-span is practically closed with sand-bars, and at Garland a similar obstruction is threatened.

Mr. Burrows's management of his work throughout, and especially under the exceptional difficulties of its first stages, his skillful handling of his party, and the thoroughness of his operations was notably fine. His assistants, C. H. McClelland, C. W. Sturtevant, and William Humphrey, transitmen, and Howard Vance and T. W. Allen, levelmen, are individually worthy of mention for alacrity, energy, and precision in their functions. McClelland's work—surveying the river proper—was extraordinary, and Howard Vance fully sustained his reputation as an expert, gained in the Missouri River survey.

Work to be done.—The field work of the survey may be regarded as completed between Fulton, Ark., and Caspiana Landing, La. About 280 miles of river, therefore, remain to be surveyed.

In view of the difficulty of gathering skilled labor in this climate (especially when there is demand for it elsewhere), it would probably be best, should the means be made available in time to take advantage of a full working season, to attempt but one main organization for this work. The gauging of the river, probably during the whole season, will still be required.

The following has been found to be about the most efficient organization:

One assistant engineer in charge.

Topographical party: One chief, three transitmen, two levelmen, two recorders, two rodmen, one boatman, one watchman, twenty laborers, and two cooks.

Gauging party, etc.: One recorder, one rodman, one sounder, two boatmen, and six gauge-keepers.

In the office it will be necessary to retain one assistant engineer in charge, four assistant engineers, and two computers.

This estimate is made upon the supposition that the boats and outfit procured during the last season's work will still be available.

I beg leave to add that I believe had the money been made available while the late field organization still existed, the work might have been finished easily for $20,000.

The amount expended during the fiscal year:

On improving the river, repairs, and care of plant was	$34,040.48
And for the survey	24,665.12
Total	58,705.60

With the balance on hand it is proposed to continue work on the notes of the survey, work with the *Florence* at work above Shreveport, and to employ the *Meigs* for about two months on obstructions too heavy for the *Howell*. The appropriation will then be so reduced as to necessitate laying up all the boats, which will be collected in a fleet at Shreveport.

The estimates for the fiscal year 1888–'89 are recapitulated as follows, to include $12,000 which can be profitably expended in employing the *Meigs* and *Wagner* when not in use on others streams:

Snag-boat *Florence*	$17,000
Snag-boat *Howell*	26,000
Snag-boats *Meigs* and *Wagner*	12,000
Construction of new boat	65,000
Expenses of same	5,000
Two crane-boats and services	30,000
Small steamer and quarter-boat and services	33,000
Dredge and services	12,500
Surveys	35,000
Office administration and contingencies	4,500
Total	240,000

Appropriations aggregating $535,765.50 were made at intervals between 1828 and 1852.

The present improvement dates from 1872, and the following amounts have been appropriated:

By act approved June 10, 1872, for improving Tone's Bayou	$20,000
For removing raft	150,000
By act approved March 3, 1873, for removing raft	80,000
By act approved June 23, 1874, for removing raft	50,000
By act approved March 3, 1875, for removing raft	20,000
By act approved August 14, 1876, for removing raft and closing Tone's Bayou.	35,000
Allotment August 27, 1877, from appropriation for repair, preservation, extension, and completion of river and harbor works, act April 10, 1869, for closing Tone's Bayou	4,500
By act approved February 7, 1878, for removing raft, etc	6,000
By act approved June 18, 1878, for removing raft and closing Tone's Bayou	24,000
For removing snags and other obstructions	25,000
By act approved March 3, 1879, for removing raft and closing Tone's Bayou	15,000
For removing obstructions	22,500
For improving upper river from Fulton, Ark., to head of raft	10,000
By act approved June 14, 1880, for removing raft and closing Tone's Bayou	25,000
For removing obstructions	60,000
For improving upper river from Fulton, Ark., to head of raft	10,000
By act approved March 3, 1881, for removing raft and closing Tone's Bayou	10,000
For removing obstructions	10,000
By act passed August 2, 1882, for improving Red River	75,000
By act approved July 5, 1884, for improving Red River	75,000
By act approved August 5, 1886, for improving Red River, making survey from Fulton, Ark., to Atchafalaya River, and completing survey of Bayou Pierre, La	75,000
Amount appropriated to June 30, 1887	802,000

Amount expended to June 30, 1887, $783,754.70.

Money statement.

July 1, 1886, amount available	$1,950.90
Amount appropriated by act approved August 5, 1886	75,000.00
	76,950.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	58,705.60
July 1, 1887, amount available	18,245.30
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	240,000.00

COMMERCIAL STATISTICS.

During the calendar year 1886, Red River was navigated by nine steam-boats, drawing from 15 inches to 3 feet light and from 3 to 9 feet loaded, which made over 131 round trips. On account of low water and no work having been done during the previous fiscal year, navigation was somewhat restricted. Cook's Landing, upper Red River, was the head of high-water navigation for severa months; Grand Ecore, the head of low-water navigation, for 4 months; and the stream was navigable to Shreveport 6 months of the year. The following *down freights* were carried:

Cotton	bales	71,805
Cotton seed	tons	9,727
Cotton-seed oil	barrels	3,420
Oil-cake	tons	3,729
Hides	pounds	29,500
Wool	do	31,000
Tallow	do	1,600
Staves	number	10,000

Cattle	head	1,700
Hogs	do	600
Wood	cords	600
Lumber, sawed	feet B. M.	1,000,000
Sugar	hogsheads	687
	barrels	564
Molasses	do	1,549

The *return freights* consisted of general merchandise and plantation supplies, the value of which was largely in excess of the products brought down the river.

The estimated value of the commerce of the stream for the calendar year 1886 was given at $12,000,000.

U 2.

IMPROVEMENT OF CANE RIVER, LOUISIANA.

Cane River is an arm of Red River, about 70 miles in length from its upper end, 2 miles below Grand Ecore, where it leaves Red River, to Colfax, where it re-enters the main stream. It was formerly part of Red River, but in 1849 a cut-off turned the river into its present bed, and Cane River has gradually filled up, until at present it is nearly dry for six months in the year. An examination was made by the United States in December, 1882, and the obstructions to high-water navigation found to be snags, logs, stumps, caved-in and leaning trees, and some rock. No estimate of cost of improvement was submitted by the engineer officer in charge, who reported the stream not worthy of improvement and the work not a public necessity. His assistant estimated the cost of removing the obstructions at $7,665.

The only appropriation made for this improvement was by act approved July 5, 1884, $2,500, and the obstructions were removed during the season of 1884, as far as practicable with that amount, resulting in freeing the channel from obstructions to a great extent, increasing the depth of water during the navigable season, and enabling steam-boats to make quicker trips. No funds have been appropriated nor any work done since.

As this stream is an arm or high-water channel of Red River, it is recommended that any future improvement be carried on with that in the main stream, in which case necessary work can be done should the interests of navigation require it. No specific amount is therefore asked for separate improvement.

The small balance available July 1, 1886, has been expended for office expenses.

During the calendar year 1886 navigation of Cane River was uncertain and of short duration, and then only for very small boats, on account of unusually low water in the main stream, on which it is largely dependent for its supply. The quantities of freights carried could not be ascertained.

Money statement.

July 1, 1886, amount available	$74.69
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886,	74.69

U 3.

SURVEY OF BAYOU PIERRE, LOUISIANA.

The Bayou Pierre region is that part of Red River Valley lying between the river proper and the pine hills on the west, and reaching from a point 2 miles below Shreveport to Grand Ecore, La. It has a southward extent of 60 and a maximum width of 9 miles.

Details of previous operations on this survey will be found in the report for 1886. (See Annual Report of Chief of Engineers, 1886, pages 1343 *et seq.*)

The item of appropriation in the river and harbor act, approved August 5, 1886, for improving Red River, Louisiana and Arkansas, provided for completing the survey of Bayou Pierre, and this was done in connection with the survey of Red River. The report of operations will be found in the preceding report on the improvement of Red River, Louisiana and Arkansas.

The small balance of funds available from the appropriation of July 5, 1884 ($138.05), was expended in connection with the allotment from the appropriation for improving Red River.

U 4.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The improvement of Cypress Bayou has included the whole navigable route from Shreveport, La., to Jefferson, Texas, via Sodo and Fairy lakes and Cypress Bayou. An examination was made by the United States in 1872, and the work of improvement begun the same year and completed in 1880, a well defined channel, marked with signboards, from Shreveport to Jefferson, a distance of 65 miles, being the result of the work. In July, 1884, a steamer was employed during the month in removing obstructions. No work has been done since.

The river and harbor act of August 5, 1886, appropriated $18,000 "to complete improvement." The approved project for the application of this amount consists in rebuilding the dredge *Lone Star*, formerly used on this work and by means of this boat the straightening and marking of the present channel through the lakes and bayou, the removal of numerous stumps therefrom, and reopening the cuts by dredging. This project was approved February 15, 1887, and the work of rebuilding and repairing the dredge was begun early in April, as soon as the lumber and materials could be delivered at Shreveport, La., where the repairs were made. On June 6 the boat was launched, and at the close of the fiscal year was nearly completed. She will be towed to Jefferson, Tex., early in July, at which point the crane machinery, heater, pump, capstan, etc., will be fitted up. As soon as completed she will begin operations, working her way to Shreveport. It is estimated that the balance available after completing the repairs will suffice for about fifteen months' work, giving a suitable channel between Jefferson and Shreveport for present needs.

The dredge was purchased some years ago out of the first appropriations for Cypress Bayou, and it has been rebuilt twice at the expense of the same work. The people of Jefferson also spent a considerable sum on the dredge and on the work before receiving assistance from the

United States. But the dredge has been used on other work, especially in Red River about as much as in Cypress Bayou, so that when the present appropriation is nearly exhausted, it will be no more than fair to allot a reasonable sum from, say, Red River, to be applied for continuing the work to Shreveport and enlarging the water-way. The estimated value of the dredge when ready for work is about $15,000, though a new one could not be built for that sum. I think that one-half of that estimate, $7,500, would be a fair equivalent, and this would allow about eight months more work on the present route, and give all the benefit required or that could be hoped for. This would afford a good high-water channel, suited to the trade now existing or to be expected. Any attempt to create a permanent low-water channel without the construction of an expensive dam, to cost about $375,000, according to Major Howell's estimate in 1874, would have no other effect than to drain the lakes. After completing this work according to the adopted project, the transfer of the dredge should be made as suggested.

A small steamboat of 125 tons burden, drawing 4 feet of water, navigated Cypress Bayou and the lakes, but for a considerable portion of the year was prevented from running by low water. The freights carried could not be ascertained. The trade of Jefferson and the country around the lakes and bayou has been largely diverted by railroads, and it is not probable that any great amount will be returned to the water route. The trade between Jefferson and Shreveport will doubtless be chiefly local.

The following appropriations have been made for this improvement:

By act approved June 10, 1872	$10,000.00
By act approved March 3, 1873	50,000.00
By act approved August 14, 1876	13,000.00
By act approved June 18, 1878	15,000.00
By act approved March 3, 1879	6,000.00
By act approved August 5, 1886	18,000.00
Amount appropriated to June 30, 1887	112,000 00
Amount expended to June 30, 1887	99,606.39

Money statement.

Amount appropriated by act approved August 5, 1886	$18,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	5,606.39
July 1, 1887, amount available	12,393.61

U 5.

IMPROVEMENT OF LOGGY BAYOU, LAKE BISTENAU, AND THE DORCHEAT BAYOU, LOUISIANA.

Dorcheat Bayou rises in Hempstead County, Ark., and flows in a southerly direction into Lake Bistenau, which empties through Loggy Bayou into Red River, about 110 miles below Shreveport, La. An examination of the system was made by the United States in December, 1882, when it was found to be obstructed with logs, stumps, leaning trees, brush, etc., and that it was navigable at high water as far up as Murrell's Point, on Dorcheat Bayou, near Minden, La. (about 70 miles above the mouth of Loggy Bayou), for about five months of the year. No estimate of cost or improvement was submitted by the engineer officer in charge, who reported the streams as not worthy of improvement, and the work not a public necessity. His assistant, who made the examination, estimated the cost of removing obstructions, building dams, and dredging where necessary, in order to increase the navigable period two months, at $19,338.

But one appropriation was made for this improvement, by act approved July 5, 1884, $5,000. With this amount the most serious obstructions to high-water navigation between Murrell's Point and the mouth of Loggy Bayou were removed. Navigation was greatly benefited by this work, the depth of water increased in many places, and boats were enabled to run to the head of navigation during six months of that fiscal year. As no funds have been available, nothing has been done since.

The improvement, like that of all streams in this part of the country, is not permanent, and if the streams were entirely cleared of obstructions during one season, new ones, caused by sliding and caving banks and the growth of vegetation, would constantly be added, and require removal from time to time. To lengthen the navigable season, dredging of bars and narrow places would be necessary. It is doubtful whether the demands of commerce would justify the expenditure necessary for such improvement. Minden, the principal shipping point, is now connected by rail with the Vicksburg, Shreveport and Pacific Railroad; consequently the importance of the water outlet has greatly diminished, although still a convenient outlet for the limited commerce of the country on the east side of Lake Bistenau and Loggy Bayou.

No appropriation is asked for this improvement. The small balance available July 1, 1886, has been expended for the care of the property pertaining to this improvement and office expenses.

Little or no commerce has been carried on in these streams since 1885. The facilities offered by rail transportation to and from Minden have diverted the larger portion of the business, and it would be difficult to change it from that channel.

Money statement.

July 1, 1886, amount available	$91.79
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	91.79

U 6.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita River has its headwaters in Polk County, Ark., in the Ouachita Mountains, and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until, joined by Tensas and Little rivers, at Trinity, La., it becomes Black River, and flowing in a southerly direction enters Red River near its mouth.

The entire length of Ouachita River is about 500 miles, and Black River is 75 miles long.

Black River, being the connecting stream between Ouachita and Red rivers, was added under the same head of appropriation with Ouachita, by river and harbor act of 1884. The present project contemplates the removal of obstructions to navigation, consisting of wrecks, logs, snags, leaning timber, etc., and the improvement of shoal places from Camden, Ark., to the mouth of Black River.

No estimate of the cost of this improvement can be submitted, as the obstructions are continually forming and require removal from time to time.

The report of previous operations in these streams will be found in Appendix T, Annual Report of the Chief of Engineers, 1886, pages 1351 and 1352.

As soon as practicable after the appropriation of August 5, 1886, became available preparations were made for the necessary repairs of the United States snag-boat *O. G. Wagner*. Having ascertained that this work could be performed more economically at Saint Louis than at New Orleans, the only other available docking place, the boat, which had been laid up at New Orleans, was towed to Saint Louis, reaching that point October 20, 1886. Repairs were at once begun and completed the latter part of December. They consisted in replating the bottom throughout with new steel plates, overhauling the crane and other machinery, repainting the boat, and other minor repairs. As soon as completed the boat was fitted out at Saint Louis and left that point December 24, in charge of E. F. White, master. She entered Black River and commenced snagging operations January 10. This work was continued between the mouth of Black River and Camden, Ark., until March 10, when, on account of high water and practical exhaustion of the appropriation, the boat was transferred to Red River.

The following obstructions were removed during the season:

	Number.
Snags pulled	301
Stumps pulled	9
Shore snags cut	157
Leaning trees cut	267

Owing to the small balance of funds available after repairing and fitting out the boat for service, operations were confined to the removal of the principal obstructions only, and this work has been of very material benefit to navigation, as nothing had been done since operations were suspended in January, 1885.

The upper river is much obstructed by leaning timber, especially in the bends, and the lower river by shoals of hard gravel and rocky ledges. The timber should be cut down to low water for some distance back from the river, and brush wing-dams should be constructed to increase the depth over the bars. The best manner of accomplishing each kind of work is by means of shore parties, with axes, brush hooks, etc., using quarter-boats, or small flats and tents. This outfit would be of service for all work of the kind on tributaries to Ouachita, as the upper river, and Bayous D'Arbonne, Bartholomew, Bœuf, and Tensas and Macon.

A small light-draught steamer, with shears and steam capstan, is much needed for use on the upper river and tributaries, to serve as a patrol, a tender for working parties, and for doing work where it would not be economical to work with so large a boat as the *Wagner*. Economy will be subserved by making the hull of steel, thereby reducing the item of repairs and increasing the life of the boat. As it would take some months to construct and equip such a boat, it is probable that four months' service is the most that could be had for the first year.

The snag-boat *Wagner* is now in excellent condition, but will require some repairs in the way of calking, painting, etc., after having laid up so long.

The cost of running this boat per month is about as follows:

Pay-roll	$1,350
Subsistence	200
Fuel, oil, and waste	250
Minor repairs and tackle	100
Total	1,900

It costs about $200 a month to take care of her if laid up alone in Ouachita River, and about $100 if cared for in the fleet. The wear and tear of cable, chains, and hoisting machinery is very great, and as the usefulness of a snag-boat depends on keeping everything in working order, a reasonable amount should be allotted for that purpose. The estimates for the year are:

Eight months' active service of the *Wagner*, at $1,900	$15,200
Four months in ordinary, at $200	800
Extraordinary repairs and maintenance of outfit	2,000
Crane boat with steam-power	4,500
Eight months' service, labor, subsistence, tools, and explosives, at $2,000	16,000
Small steel steam-tender and equipment	15,000
Four months' service, wages, fuel, subsistence, tools, etc., at $1,250	5,000
Office, contingencies, administration, etc	1,500
Total, from Camden, Ark., to Red River	60,000

It is asserted that during a good stage of water the greater bulk of shipments is made by steamboats, and that testimony before the Interstate Commerce Commissioners showed that "when navigation is suspended, and boats can not get to Monroe, railroad rates are increased 100 per cent."

The obstructions at mouth of Red River, Catahoula Shoals, and other bars above, interrupted navigation below Monroe, the most populous and fertile part of the stream, during the season when the larger part of the supplies are purchased by the planters and merchants in that vicinity.

The former appropriations are as follows:

By act approved Mar. 3, 1871	$51,000
By act approved June 10, 1872	100,000
By act approved Mar. 3, 1873	60,000
By act approved Aug. 14, 1876	12,000
By act approved June 18, 1878	10,000
By act approved Mar. 3, 1879	10,000
By act approved June 14, 1880	8,000
By act approved Mar. 3, 1881	12,000
By act passed Aug. 2, 1882	12,000
By act approved July 5, 1884	15,000
By act approved Aug. 5, 1886	17,500
Total amount appropriated to June 30, 1887	307,500

The amount expended on present project, including cost of iron-hull snag-boat and outfit, to June 30, 1887, was $193,912.13.

Money statement.

July 1, 1887, amount available	$92.06
Amount appropriated by act approved July 5, 1884	17,500.00
	17,592.06
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886	17,592.06
Amount that can be profitably expended in fiscal year ending June 30, 1889	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the fiscal year, Camden was the head of high-water navigation for a period of six months. Catahoula Shoals, about 145 miles below Monroe, was the head of low-water navigation from July to November, during which period boats were unable to pass this obstruction. Thirteen steam-boats, of from 100 to 1,200 tons burden, drawing from 1½ to 4 feet light, and from 5 to 8½ feet loaded, made more than 80 round trips. Three of these boats ran through from Saint Louis, Mo., to Monroe, La., and the others from New Orleans, La. The following down freights were carried:

Cotton	bales	62,900	Lumber (sawed)	feet B. M.	1,933
Cotton seed	tons	1,610	Timber (logs)	number	121,000
Cotton-seed oil	barrels	750	Seed cotton	sacks	64
Staves	number	530,000	Moss	bales	177
Cattle	head	108	Sugar	hogsheads	64
Hogs	do	561	Molasses	barrels	89
Wood	cords	2,100			

With return freights of agricultural implements, building materials, horses, mules, cattle, wagons, general merchandise, and plantation supplies, estimated at 21,000 tons, and valued at not less than $3,660,000.

In addition to the above there were 16 smaller steamers, averaging about 90 tons each, which ran from Trinity and Monroe to local points and into the tributaries, reshipping on the through boats or by railroad; but no record of the cargoes carried is obtainable.

U 7.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North or Corney Branches, near Farmerville, in northern Louisiana. It flows in a southeasterly direction and enters Ouachita River about 6 miles above Monroe, La.

An examination and survey were made in 1883, and the plan of improvement is based upon the latter. The project contemplates the removal of snags, logs, wrecks, and leaning trees, etc., obstructing navigation between Stein's Bluff and the mouth, a distance of 42½ miles, at an estimated cost of $15,000.

This bayou, like the other tributaries of Ouachita River, is navigable only during high stages of water in the main stream. The only work heretofore done was performed in 1884, and resulted in the removal of obstructions from about one-half of that portion of the stream in which improvement is contemplated by the present project; improving navigation and lessening the dangers thereof very materially. The work, however, is not permanent, as new obstructions are added from time to time, which require removal in the interests of safe navigation.

A party was organized and began work at the mouth of the bayou November, 17, 1886. Operations were conducted under the supervision of Superintendent J. T. Dorey, in connection with those on Bayou Bartholomew, and were confined principally to cutting the heavy growth of brush and leaning trees, and some high stumps, which formed dangerous obstructions during high water. After working 4 miles up the bayou, back-water from the Ouachita became troublesome, and the party moved 10 miles up-stream, where the stage of water was more favorable, expecting to work over the intervening space as soon as the water receded; but on account of a sudden rise, it became necessary to disband the party and suspend operations early in December. Seventeen miles of the bayou were worked over and the following obstructions removed:

Leaning trees cut	number	262
Shore snags cut	do	37
Water snags removed	do	45
Stumps cut	do	27
Brush cut	square yards	2,345

This work resulted in the removal of many dangerous obstructions from the lower part of the stream, but the sudden rise of the bayou prevented its successful continuance.

With the balance available it is proposed to resume operations in connection with work in Bayous Bartholomew and Maçon, the amount being too small to permit organization of a special party for the work.

With the amount asked for the fiscal year ending June 30, 1889, it is proposed to continue the work of cutting leaning timber, and removing logs and snags. As the work can be carried on under the superintendent of the workou Bayou Bartholomew, $4,000 is considered ample for labor, subsistence, and other supplies.

Reliable statistics could not be obtained, for reason given in report on Bayou Bartholomew. The commerce of the stream does not amount to more than 10,000 bales of cotton, besides rafting timber and staves, and return freights of general merchandise and plantation supplies. Much of the products of the country is hauled to Monroe before the bayou is at a good navigable stage.

The former appropriations were:

By act approved July 5, 1884	$5,000.00
By act approved August 5, 1886	2,000.00
Amount appropriated to June 30, 1887	7,000.00
Amount expended to June 30, 1887	6,330.77

Money statement.

July 1, 1886, amount available	$25.93
Amount appropriated by act approved August 5, 1886	2,000.00
	2,025.93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,356.70
July 1, 1887, amount available	669.23
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June, 30, 1889	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

U 8.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

This stream is a tributary of Ouachita River. It rises in southeastern Arkansas, within a few miles of Pine Bluff on the Arkansas River, and following an exceedingly tortuous course flows at first nearly parallel to the Arkansas River, at a distance varying from 15 to 30 miles; then parallel to the Mississippi, at about the same average distance, and after entering Louisiana diverges to the southwest and enters the Ouachita River opposite Ouachita City.

The States of Louisiana and Arkansas have at various times expended funds for surveys and improvements of this bayou. Examinations were made by the United States in 1872, 1879, and 1880. At Baxter, Ark., the Little Rock, Mississippi River and Texas Railroad crosses the bayou, forming a bar to all navigation above, except for stave-boats, of which there are a great many in this part of the stream.

An examination of the bayou from Baxter to the Lincoln County line, Arkansas, was made in December, 1884, the report on which disapproves the improvement of this portion of the river at present.

The plan of improvement is based upon a report submitted by Major Benyaurd in 1880, contemplating cutting overhanging timber, and removing wrecks, snags, etc., obstructing navigation, from Baxter, Ark., to the mouth, an estimated distance of 213 miles.

The estimated cost was given at $26,862, but this estimate was based upon a plan of operations for twelve months, or two consecutive seasons' work, whereas, owing to the small amounts appropriated, operations have now extended over six years. For this reason the cost of the work will be increased, as new obstructions are continually forming, and after the work is thoroughly completed, these will require removal from time to time; hence no estimate for permanent improvement is given.

The work heretofore done has extended over nearly the entire portion of the bayou included in the project, and has greatly lessened the dangers of navigation.

About the middle of November, 1886, a party was organized at Ouachita City, La., with Superintendent J. T. Dorey in immediate charge. Operations were commenced at the mouth of the bayou November 20, and continued up-stream until January 20, to Point Pleasant, La., about 50 miles, when, on account of unfavorable weather and high water, the work was suspended.

The following obstructions were removed:

Logs and snags pulled and cut	number	742
Stumps cut	do	875
Shore snags cut	do	752
Side jams removed	do	2
Leaning trees cut	do	2,918
Willows cut	square yards	19,550

This work was performed by two parties, the larger one removing obstructions from the bank and cutting leaning trees, while the second party, consisting of from five to nine men, worked in small flat-boats, removing obstructions from the channel as far as their appliances would permit, and cutting up and pulling out any trees which fell into the stream. It has been thoroughly done, and has placed the bayou in good navigable condition during high and medium stages, as far as it progressed, and the steamboat men navigating the stream have expressed themselves well pleased at the improvement.

Navigation to Point Pleasant, the head of low-water navigation, might still be greatly facilitated by the removal of the logs and snags buried in the channel. This, however, can only be accomplished by the use of steam-power or dynamite, and on account of the limited funds was not undertaken during the past season, the object being to give the greatest benefit to navigation with the amount available, according to the plan pursued.

At the close of the fiscal year the bayou had fallen to a stage suitable for efficient work, and with the available balance operations will be resumed early in July at Point Pleasant, and carried up-stream until the appropriation is exhausted.

With the amount asked for the fiscal year ending June 30, 1889, it is proposed to continue cutting brush and leaning trees, and to remove logs and stumps by a liberal use of high explosives. A small flatboat, with steam capstan and light crane or shears, and sufficient room for quarters, should be provided.

Estimates for such a boat are included in the estimate for Ouachita River.

For immediate use it would be necessary to hire a suitable boat. The estimates are as follows:

Four months' work, including subsistence and transportation, at $1,200	$4,800
Four months' hire of boat, at $250	1,000
Explosives	200
Tools and outfit	300
Office and administration	200
Total	6,500

Shipments to and from the bayou are made by boats connecting with the Ouachita River boats and the Vicksburg, Shreveport and Pacific Railroad at Monroe, but there is no statistical record obtainable. As the bayou is at present the only means of transporting the products of the bordering country, it is estimated that the freighs carried were about the same as reported in 1886. It is stated that more cotton is brought out of Bartholomew than is shipped by boats on the Ouachita River above Monroe, La.

The following appropriations have been made for this improvement, viz:

By act approved March 3, 1881	$8,000.00
By act passed August 2, 1882	5,000.00
By act approved July 5, 1884	5,000.00
By act approved August 5, 1886	5,000.00
Amount appropriated to June 30, 1887	23,000.00
Amount expended to June 30, 1887	21,116.55

Money statement.

July 1, 1886, amount available	$21.18
Amount appropriated by act approved August 5, 1886	5,000.00
	5,021.18
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,137.73
July 1, 1887, amount available	1,883.45
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,500.00

U 9.

IMPROVEMENT OF BAYOU BŒUF, LOUISIANA.

Bayou Bœuf rises in southeastern Arkansas, flows in a southerly direction, and enters the Ouachita River at Stafford's Point, about 10 miles above Harisonburgh, La.

The plan of improvement is based upon an examination made by the United States in 1880. The project contemplated the removal of snags, logs, and leaning timber obstructing navigation between Wallace's Landing and the mouth of the bayou, a distance of 280 miles, at an estimated cost of $20,000. This estimate, however, was for a project of ten months' (two consecutive seasons) work. Owing to small appropriations, the work has already extended over a period of six years, and the cost increased accordingly. New obstructions are continually forming, and even after the work is once thoroughly completed these will require removal from time to time; hence no estimate for permanent improvement is given. An examination of the three outlets of Bayou Bœuf near Point Jefferson, La., was made in 1884, and their closure recommended at an estimated cost of $8,500.

The work heretofore done was carried on during 1881, 1882, and 1884. The removal of obstructions greatly benefited and lessened the dangers of navigation, and boats were enabled to run to Point Jefferson during high water.

The act of August 5, 1886, appropriated $5,000 for continuing improvement and closing Outlet No. 1, near Point Jefferson. On account of the lateness of the season when the funds became available, and the small amount appropriated, which was but little in excess of the estimate for the dam closing Outlet No. 1, it was not deemed advisable to begin work during the fall of 1886. Even had the dam been built at once, without set-back by bad weather or high water, it would not have consolidated sufficiently to withstand the spring floods, as it would have been liable to attack in the rear as well as in front, and have been almost certain to yield to inequalities of pressure in its spongy state. For these reasons it was recommended and approved that the funds be kept entire for the following season's operations.

A re-examination of the three outlets near Point Jefferson was made by Assistant Engineer Walter S. Davis in February, and a personal examination about the middle of June, 1887. It was found that it would be a waste of public funds to apply any part of the allotment to the removal of snags, logs, etc., before Outlet No. 1 was closed by a high dam, and if not closed soon, Bayou Bœuf would run into Lake La Fourche and be dissipated in the swamps beyond, and the bar at Point Jefferson probably closed across, thus shutting out all water communication above, except in high water, and cause disastrous overflows of the country towards Oak Ridge, which is now being extensively cultivated. The closure of No. 1 alone would not be sufficient, except, perhaps, to keep the bayou within the old line for a time. Numbers 2 and 3 should also be closed to prevent backwater from Bayou Bœuf and water from Bonne Idee from attacking No. 1 in the rear, and also to combine in directing all the water down the main channel. The removal of snags, logs, etc., would do no good at present, for so long as the bars exist there can be no navigation in low water, and when there is sufficient depth on the bars the logs are in deep water.

Finding that the planters in that vicinity and others interested proposed to restore the old levee by subscription, and for the reasons above stated, I recommended that the entire amount available be applied to filling the outlets in their order, so far as it would go, by entering into agreement with the planters who propose to restore the old levee, and to whom the matter of protection from overflow is of vital importance. It would have been useless to advertise, if desired to fill all the outlets; the amount of work being too small for regular levee contractors to touch, except at high prices, and they will soon be engaged on the main levees of the Mississippi; and also too small for a small subcontractor to buy the tools, etc. This project was approved July 12, 1887, and work will be begun as soon as the necessary arrangements can be made. It is believed that this plan will accomplish the closing of all three outlets this season, and result in washing the bars below Point Jefferson by concentrating all the flood water in the main channel; and the steamboat men navigating the stream state that such application of the funds will benefit navigation more than if spent in any other way.

With the appropriation asked for the fiscal year ending June 30, 1889, it is proposed to build brush wing-dams to scour the bars, cut leaning timber, remove shore-slides, and remove logs and snags from the channel by use of explosives. Until a suitable boat can be had for general use on the tributaries to Ouachita River, it will be necessary to hire a small steamer or a flatboat and rig light shears or crane for service with a steam capstan. A chopping party of fifteen to twenty men can be employed to advantage for at least six months. An outfit of skiffs, tents, and tools will be required, and means of transportation. The estimates are:

For hire of boats	$1,800.00
Wages, subsistence, etc., six months, at $1,500	9,000.00
Office and administration	200.00
Total	11,000.00

The former appropriations were:

By act approved March 3, 1881	$5,000.00
By act passed August 2, 1882	5,000.00
By act approved July 5, 1884	5,000 00
By act approved August 5, 1886	5,000.00
Amount appropriated to June 30, 1887	20,000.00
Amount expended to June 30, 1887	15,018.59

Money statement.

July 1, 1886, amount available	$4.32
Amount appropriated by act approved August 5, 1886	5,000.00
	5,004.32
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	22.91
July 1, 1887, amount available	4,981.41
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,000.00

COMMERCIAL STATISTICS.

During the calendar year 1886, one steam-boat of 176 tons burden, drawing 2 feet light and 6¼ feet loaded, made ten round trips in the bayou. A smaller steamer with barges, and two tugs with barges, made occasional trips. The river was navigable to Point Jefferson for six months.

The following down freights were carried:

Cotton	bales	6,100
Cotton-seed	tons	700
Staves	number	63,000
Cattle	head	20
Hogs	do	28
Wood	cords	124

Return freights of general merchandise and plantation supplies.

U 10.

IMPROVEMENT OF TENSAS RIVERS AND BAYOU MACON, LOUISIANA.

Tensas River has its source in northeastern Louisiana, in Lake Providence, flows in a southerly direction, and unites with Ouachita and Little Rivers, at Trinity, La., in forming Black River. By river and harbor act of 1884, Bayou Macon was united under the same head of appropriation with Tensas River. This bayou rises in Desha County, southeastern Arkansas, flows in a southerly direction, entering Tensas River about 40 miles above its mouth.

Examinations of these streams were made in 1880, upon which the present plan of improvement is based. The project contemplates removing snags, logs, and leaning timber obstructing navigation in the Tensas, between Dallas and its mouth (about 180 miles), at an estimated cost of $23,000, and the removal of the same class of obstructions in Bayou Macon, from Floyd, the present head of navigation, to its mouth (about 130 miles), at an estimated cost of $17,000.

The work heretofore done has been confined to Tensas River, as the funds appropriated in 1884 were not sufficient to extend operations into Bayou Macon, and has benefited navigation by the removal of obstructions from that portion of the stream in which it was carried on. This work, however, is not permanent, as new obstructions are added from time to time, which will require removal in the interest of safe navigation.

As no work had been done in Bayou Macon, and as it was of greater commercial importance and more dangerously obstructed than any part of the Tensas, operations during the past year were confined to that stream. Two chopping parties of twelve men each, with outfits of skiffs, tents, and tools, were organized November 14, 1886, at Delhi, La. The work was carried on under the superintendence of Mr. Walter S. Davis, one party working up-stream and the other towards the mouth. By the end of December the upper party had reached Floyd, the present head of navigation, 30 miles above Delhi, and turning back joined the other, about 40 miles below Delhi. With this combined force work was continued down-stream to the mouth of the bayou, which was reached about the end of January, when, as the water was rising, operations were suspended. The work consisted in cutting the snags to low-water surface, sawing all logs within reach, felling and cutting up the overhanging trees, and girdling such as would impede navigation at high water. The following is a summary of the work performed:

Snags cut to low-water surface, number	2,385	Side jams removed ......number..	55
Stumps pulled ....number..	8	Leaning trees cut ....do....	5,700
Shore snags cut ....do....	890	Leaning trees topped.......do....	367
Logs removed from channel do....	4,890	Leaning trees girdled.......do....	5,970
Jams removed ....do....	39	Willows and undergrowth cut from banks............square yards..	5,472

The work of the past year resulted in the removal of the principal obstructions from Bayou Macon, between Floyd and the mouth, but in consequence of sliding and caving banks it is not permanent and should be repeated to remove jams that will form after high water from the large number of trees cut. Steamboat men navigating the bayou have spoken in most commendatory terms of the benefits derived from the past season's operations.

No work has been done in Tensas River since 1884. The lower portion, for about 80 miles above the mouth, is in good navigable condition and comparatively free of obstructions. Until recently the Upper Tensas, above the mouth of Macon, has been of little or no commercial importance, and large plantations along both sides of the bayou have lain deserted for more than twenty years. These plantations, though highly productive, were abandoned on account of successive overflows from the Mississippi River when the levees along the western bank washed away. These levees have been repaired within the past year, and many of the deserted plantations have been reclaimed, which will probably give to that portion of the stream an amount of commerce rendering it worthy of improvement.

With the small balance available, it is proposed to resume the operations in Bayou Maçon, suspended by high water in January, in connection with the work on Bayous Bartholomew and D'Arbonne; the amount being too small to organize a special party for this work.

With the amount asked for the fiscal year ending June 30, 1889, it is proposed to continue the work of cutting leaning timber and removing logs and snags, and to build brush dams where required. The estimates are as follows:

Hire of boat	$1,800.00
Six months' labor, subsistence, etc., at $1,500	9,000.00
Office contingencies and administration	200.00
Total	11,000.00

Reliable commercial statistics could not be obtained, for the same reason given in the report on Bayou Bartholomew. Bayou Macon and Lower Tensas, it is asserted, ship 10,000 bales of cotton during the years when the water rises early in the season, with return shipments of merchandise approximating $400,000 in value.

The former appropriations were:

By act approved March 3, 1881	$3,000.00
By act approved July 5, 1884	4,000.00
By act approved August 5, 1886	4,000.00
Amount appropriated to June 30, 1887	11,000.00
Amount expended to June 30, 1887	10,599.61

Money statement.

Amount appropriated by act approved August 5, 1886	$4,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,599.61
July 1, 1887, amount available	400.39
Amount (estimated) required for completion of existing project	$29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

U II.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

This stream rises in Webster and Choctaw counties, Mississippi, flows in a general southwesterly direction, and enters the Mississippi River at Grand Gulf, Mississippi, having a length estimated to be about 400 miles.

The bridge of the Louisville, New Orleans and Texas Railroad, about 15 miles above the mouth, and that of the Vicksburgh and Meridian Railroad, about 90 miles above the mouth, neither having draws, form obstructions to free and safe navigation at all stages of water. Two highway bridges without draws, 25 and 78 miles above the mouth, respectively, also form barriers to navigation. The river above the first railroad bridge at present is navigated only by flatboats carrying staves, etc.

Old settlers assert that previous to the building of the railroads large quantities of cotton and produce were shipped annually down the river in flat and keel boats, and it is probable that if the bridge obstructions were remedied, and the bank and channel obstructions removed, at least a portion of the commerce of the country bordering the river would find a way to market by this route to the Mississippi River. Owing to comparatively short distances between points on Lower Big Black and the railroads which border and cross it, as well as its proximity to Yazoo River at Satartia, it is impossible to form any estimate of the benefits to be derived from the thorough improvement of the river between Cox's Ferry and its mouth.

An examination of the stream was made by the United States in 1881, and the project for its improvement contemplated the removal of snags, logs, overhanging timber, and several wrecks obstructing navigation from the mouth to Cox's Ferry, 130 miles above, at an estimated cost of $32,000.

The only work that has been done towards the improvement of this river was performed in 1884-'85, when a chopping party began operations at the mouth and continued up-stream about 75 miles. This work resulted in the removal of the principal obstructions and increased the facilities for navigating that portion of the river in which it was done.

No work was done during the fiscal year. The appropriation in river and harbor act of August 5, 1886, contained the following proviso: No part of this appropriation "shall be used until the State of Mississippi shall have first caused the bridges over said stream south of the Vicksburgh and Meridian Railroad to be so constructed as not to obstruct the navigation of said stream." The legislature of Mississippi had adjourned before the passage of this act, and as it meets biennially the next session does not assemble until January, 1888. No further work is therefore contemplated until the State has taken the necessary legislative action, and no additional funds are asked for the improvement of this river.

The commerce is practically the same as reported in 1886. About the same quantity of staves was brought out of the river, and this comprises the principal traffic at present.

The former appropriations were:

By act approved July 5, 1884	$5,000
By act approved August 5, 1886	5,000
Amount appropriated to June 30, 1887	10,000
Amount expended to June 30, 1887	5,000

Money statement.

July 1, 1886, amount available	$258.38
Amount appropriated by act approved August 5, 1886	5,000.00
	5,258.38
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	258.38
July 1, 1887, amount available	5,000.00
Amount (estimated) required for completion of existing project	22,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

U 12.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River is formed by the junction of Yallabusha and Tallahatchee rivers in Le Flore County, Mississippi; it is about 264 miles in length, flows in a general southwesterly direction, through one of the richest sections of country in the South, and enters the Mississippi River 9 miles above Vicksburg.

An examination of the wrecks of gunboats, steamers, and other obstructions placed in the river during the war, was made by the United States in 1873, and a similar examination, which included the natural obstructions to navigation, was made in 1874. The project contemplates the removal of wrecks, logs, snags, overhanging timber, etc., obstructing navigation throughout the entire length of the river. The work, however, can not be permanent, as new obstructions, caused by floods, caving banks, etc., are brought into the river each year, and require removal to render navigation safe; consequently no detailed estimates have been submitted.

The wrecks of eleven steamers sunk during the war were removed by contract during 1873–'74. In 1875 and 1877 the United States snag-boat *O. G. Wagner* was employed in removing wrecks and other obstructions. The snag-boat *John R. Meigs* was completed in October, 1879, and the principal work since has been carried on with that boat. The results of the work done are marked; the large number of wrecks and many natural obstructions, which limited the navigable season, have been removed, and the river is navigable throughout the entire year.

After passage of the act of August 5, 1886, an examination of the snag-boat *Meigs* was made and it was thought safe to put her into commission without repairing the iron hull and deck. It was therefore recommended that the boat be fitted out at once for service in Yazoo River, making only such repairs as were immediately necessary, and postponing the extensive repairs contemplated till the close of the season. This plan having been approved, the repairs were begun September 6. The wooden decks were renewed over the guards and calked throughout; the smoke stacks renewed and put up, new breeching fitted, and stumps repaired; the capstan machinery overhauled and renewed, new escape pipes fitted, and a general overhauling of steam fittings, boilers, engines, and wheel. These repairs were completed and the *Meigs*, in charge of P. R. Starr, master, left Vicksburg for Yazoo River October 21, to begin snagging operations up-stream. This boat has been employed in Yazoo River during the fiscal year as follows: From October 21 to November 30, December 27 to January 15, May 6 to 10, and June 11 to 30.

During the intervening times she has been employed in Tallahatchee and Yallabusha rivers, and Tchula Lake, Mississippi, tributaries of the Yazoo, and in Red River, Louisiana, having been almost constantly at work since October 21, 1886.

The following is a summary of the work performed in Yazoo River:

Snags pulled	number	880
Stumps pulled	do	85
Shore snags cut	do	460
Leaning trees cut	do	9,063
Leaning trees girdled	do	61
Brush cut	square yards	360
Tree slides removed	number	2
Steamers assisted over bars, where obstructing navigation	do	1
Steamboat boilers removed from channel	do	2

One sunken flatboat and part of wreck of steamer *Mary E. Keene* were removed from channel at French's Bend.

Nearly all the snags and stumps were taken directly from the channel, and all the leaning trees and shore snags were in or obstructing the channel. This work extended over the entire river, and resulted in putting it in fair navigable condition, except in the 84 miles above Yazoo City to Wasp Lake, and below Yazoo City at Short and O'Neil's creeks, where considerable work is yet required.

The river men seem to be much pleased, both as to quantity and quality of work performed. As stated above, the work is not permanent.

After every rise and fall new snags appear, and where the banks are heavily timbered trees slide into the river singly and by dozens, and, having so much sediment sticking to their roots, form dangerous snags difficult to remove.

During the last fifty years fifty-four steamboats have been lost and destroyed in this river, about twenty of which were wrecked during the war. One above mouth of Big Sunflower and one at French's Bend are reported as badly in the way, and four others as more or less in the channel. If appropriations were made so as to allow about four months' work each year, this river could be kept in good navigable condition.

During the month of July the *Meigs* will continue snagging operations between Yazoo City and Wasp Lake, and below Yazoo City at Short and O'Neil's creeks.

At the close of the month operations will have to be suspended, as the available balance will probably be required for the proper care and preservation of the boat until additional funds are appropriated. The temporary repairs of the iron snagboat *Meigs* in September and October, 1886, enabled her to do a good season's work without disaster, but it is not considered safe to use her another year without a complete overhauling. There are now seventeen holes and cracks in the bottom and sides, mostly forward of the midship section, some of them as much as 6 feet long. The boat is kept afloat partly by water-tight compartments, but chiefly by the method of battens, which are long 3-inch planks, cushioned with old blankets or mattress-filling, and held in place by wedged stanchions.

While this method is a necessity, it is very destructive to the boat in shoal water, as in hauling over the bars the weight of the boat is made to bear upon the stanchions, and so punch up the decks. A special item of appropriation should be made for this work; but if this can not be done, the cost will have to be proportioned among the several streams in which she is to work. I have made careful estimates for each kind of work required—docking and cost of delivering and returning the boat. The *Meigs* was built by the Western Iron Boat Building Company, and plans and templets are all preserved at Carondelet. The only docks within reasonable distance on which the boat can be hauled out convenient to iron-workers are at South Saint Louis.

ESTIMATE.

Towing or running to Carondelet	$650
Docking and demurrage	450
Stripping old bottom, straightening floors, putting on new steel bottom, $\frac{5}{16}$ inch, double riveted, and painted inside and out	6,000
Same for sides and bow between bilge and deck-strake	450
Renewing iron deck beams and stanchions, and butting beam	350
New wood-work. deck, roofing, kevels, cleats, guards, etc	450

Repairing engines, wheel, heater, pumps, hoisting gear, capstans, shears, heel posts, etc	$450
New canvas deck cover, roofing, etc	250
Painting hull, upper works, deck, roof, glazing, etc	500
Towing or returning boat to Vicksburg	450
Total	10,000

The cost of steel bottom might be reduced by $600 if single riveting be adopted, but the boat will be much stronger if double riveted.

This is quite essential, as it is a common event to work the boat over bars with a depth considerably less than her draught.

A small steam-boat, with crane and steam capstans, is very much needed for the upper part of Yazoo and for the smaller streams in the portion of the district east of the Mississippi.

Such a boat, if built of steel, will last for many years with but little expense, except for tools and outfit. The cost of such a boat fully equipped will be $15,000, and $5,000 will be sufficient for expenses for the first season's work, as it will take about six months to complete and fit her for work. A crane-boat with steam-boiler and capstans, and quarters for a working party of a dozen or fifteen men, is also required for general use on the bayous and smaller streams.

At present it is necessary to charter, and it is very difficult to hire or even to find suitable boats.

The cost of such a crane-boat, which can be built and equipped in less than three months, is estimated at	$4,600
Eight months of crew, subsistence, etc., at $1,200	9,600
Tools and maintenance of plant, fuel, etc	600
Care when laid up	200
Total	15,000

The bar at the mouth is becoming a serious obstruction to the free navigation of Yazoo River in low water. Boats that could go without hinderance to Sharkeys, on Tallahatchee River (375 miles from Vicksburg), in low water are prevented from entering or leaving at such times without lightening.

Temporary relief can be given by brush wing-dams, and no doubt the bar could be washed away by the construction of jetties. I recommend, however, the construction of a pumping-dredge, to be used on this and other bars in the district where needed.

The cost would be small, as will be seen from the following estimate

Hull and deck-house, and quarters		$2,000
Boiler, furnace, and feed-pump		750
Steam capstan		450
Deck-pump		50
Pressure-pump		450
Centrifugal dredge-pump, pipes, elbows, discharge, and fitting driving-engine, and crane or shears		2,500
Piping, fitting, jacketing, tools, outfit, cables, etc		800
Cost of dredge		7,000
Monthly expenses:		
Overseer, engine-driver, crew, and subsistence	$540	
Fuel, oil, and waste	125	
Petty repairs	75	
	740	
Total season, say five months in the year, in the district		3,700
Care for seven months, at $75		525
Total		11,225

The *Meigs* is the largest boat in the district, and is the one employed on the heaviest work, which the other boats can not handle. She is therefore sent to Red and Ouachita rivers, as well as to Yazoo and its larger tributaries. A greater allowance must be made for her services, not only because she carries a much larger crew than any of the others, but the wear and tear of hoisting machinery is much greater.

During active service the monthly expenses are as follows:

Pay-roll	$1,800
Subsistence	300
Fuel, oil, and waste	250
Repair of tackle, chains, etc	250
	2,600

If laid up alone at Vicksburg the cost is $250 a month, and if with the fleet about $100.

As it will take about two months to complete the repairs now absolutely necessary, including the time for delivery and return, seven months' service is probably all that can be expected in Yazoo River.

The estimates for the *Meigs* are therefore as follows:

Special repairs	$10,000
Seven months' service, at $2,600	18,200
Three months' in ordinary, at $250	750
Extraordinary repairs, maintenance of tools and outfit, etc	3,000
Total estimate for *Meigs*	31,950
For steam-tender and services	20,000
For crane-boat and services	15,000
For centrifugal pump-dredge and services	11,225
For office and administration	1,825
Total	$80,000

This amount can be profitably expended in one season.

There are two bridges across Yazoo River, one near Vicksburg and the other just above Yazoo City. The latter, a county bridge, is a very dangerous structure, situated just above a sharp bend.

The bridge should be rebuilt so as to give clear openings of at least 125 feet.

The Georgia Pacific Railroad Company was authorized by act approved March 3, 1887, to build a bridge near Fort Loring, about 8 miles below Greenwood. It is understood that plans will be submitted at an early day.

The former appropriations were:

By act approved March 3, 1873, applied to the removal of eleven wrecks sunk during the late war	$40,000.00
By act approved Mar. 3, 1875	12,000.00
By act approved Aug. 14, 1876	15,000.00
By act approved June 18, 1878	25,000.00
By act approved Mar. 3, 1879	15,000.00
By act approved June 14, 1880	12,000.00
By act approved Mar. 3, 1881	6,000.00
By act passed Aug. 2, 1882	8,000.00
By act approved July 5, 1884	10,000.09
By act approved Aug. 5, 1886	15,000.00
Amount appropriated to June 30, 1887	158,000.00
Amount expended to June 30, 1887	154,039.55

Money statement.

July 1, 1886, amount available	$1.47
Amount appropriated by act approved August 5, 1886	15,000.00
	15,001.47
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	11,041.02
July 1, 1887, amount available	3,960.45
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	80,000.00

COMMERCIAL STATISTICS.

During the calendar year 1886 about a dozen steam-boats navigated the river, with tonnage of from 30 to 250 tons each, and drawing from 12 to 30 inches light and 3 to 5 feet loaded. The river was navigable the entire year, and the estimated value of the commerce was given at $2,645,000.

The following freights were carried:

Cotton	bales..	40,000
Cotton seed	tons..	5,000
Staves	number..	100,000

Return freights of general merchandise and plantation supplies, estimated values, $1,000,000.

From September 1 to December 31 embraced part of what is known as a "short crop year," estimated short from 30 per cent. to 45 per cent., according to locality. A portion of the freights which formerly went by river is now moved by the Illinois Central Railroad.

In addition to the above, the commerce of Big Sunflower and Tallahatchee rivers and other tributaries passes up and down this stream.

U 13.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Where the Yazoo River reaches the head of Honey Island, about 220 miles above its mouth, it divides into two branches, the westerly one retaining the name of the river, while the easterly and narrower branch is called Tchula Lake or River. The distance from the head to the foot of the island, where the two branches again unite, is about 67 miles.

Very productive plantations join one another along the banks of the lake, and the amount of cotton raised annually is estimated to be about 20,000 bales, which was formerly brought to market via Yazoo River and Tchula Lake, or hauled in wagons long distances to the southern division of the Illinois Central Railroad. This road has now constructed a line from Yazoo City to the mouth of Yallabusha River, which touches Tchula Lake at several points, and has a tap line from Tchula City to the main line at Durant, Miss.

This road will no doubt transport most of the cotton which has to be marketed before navigation opens in the lake.

An examination was made by the United States in 1879, and the project based thereon contemplated the removal of snags, logs, overhanging trees, etc., obstructing navigation, to enable light-draught boats to enter the lake earlier in the season.

The estimated cost of this improvement was $10,000, but this estimated was made with the idea of performing the work during one low-water season.

Nearly the entire estimate has been appropriated, but it has come at such irregular periods, extending over six years, that the work has never been completed as projected, and even if once thoroughly completed it will have to be gone over from time to time to remove additional obstructions which are continually forming.

Work was begun in 1881 and continued in 1882 and 1884. Navigation was considerably improved by the removal of overhanging timber, snags, etc., and boats enabled to enter the lake earlier and run much later in the season.

The United States snagboat *Meigs*, P. R. Starr master, performed a week's work, from December 19 to 25, 1886, in the lake, when high water necessitated her withdrawal.

This work was resumed by the boat April 11, and continued during the month.

Operations consisted chiefly in cutting brush and overhanging trees, and resulted in giving a good navigable channel, at least 90 feet in width, for a distance of 44 miles, leaving about 23 miles to be worked over. The following is a summary of the work performed:

Snags pulled	number..	39
Stumps pulled	do....	84
Shore snags cut	do....	20
Leaning trees cut	do....	4,037
Leaning trees girdled	do....	324
Brush cut	square yards..	320
Wrecks removed	number..	1

Should the stage of water be favorable while the snag-boat *Meigs* is in that vicinity, the small balance available can be expended to advantage.

The lake is not so crooked as the river-side of Honey Island, but is very narrow in places, and covered with a heavy growth of timber and brush to the water's edge.

There are three large sand-bars in the lake; one at the head, and the others 20 and 50 miles below, respectively. The bar at the head is gradually enlarging from deposits, and each year the water in the Yazoo will have to be a little higher before boats can enter at that end. Were these bars removed, and the timber and brush thoroughly cleaned from the banks, it is probable that the channel would scour out and give a greater depth of water; but in view of the cost of this work and the decreased commerce of the stream on account of railroad facilities, it is doubtful if such expenditure would be justified.

The snagboat *Meigs* is too expensive and her services are too necessary for Yazoo River proper, and Tallahatchee River, to permit her being used in Tchula Lake, except for a short time and in an emergency. I recommend, therefore, the use of a flatboat and a large chopping party to cut brush and leaning trees so as to widen the high-water channel. Logs and stumps can be removed by use of high explosives. The sum of $6,000 can be spent to good advantage in that way. Brush dams at the upper end and at the bars below can be built at small expense with material cut in clearing the banks, and a considerable increase of depth obtained by their aid.

The former appropriations were—

By act approved March 3, 1881	$3,000.00
By act passed August 2, 1882	2,500.00

By act approved July 5, 1884	$1,500.00
By act approved August 5, 1886	2,000.00
Amount appropriated to June 30, 1887	9,000.00
Amount expended to June 30, 1887	8,480.82

Money statement.

July 1, 1886, amount available	$153.24
Amount appropriated by act approved August 5, 1886	2,000.00
	2,153.24
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,634.06
July 1, 1887, amount available	519.18
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000.00

COMMERCIAL STATISTICS.

During the calendar year 1886, four steam-boats, drawing 20 inches light and about 5 feet loaded, with tonnage of from 100 to 216 tons each, navigated this stream from January 1 to July 1, making 86 round trips, and carrying the following freights:

Cotton	bales	6,000
Cotton seed	tons	2,500

Return freights of general merchandise and plantation supplies, estimated value, $150,000.

U 14.

IMPROVEMENT OF YALLABUSHA RIVER, MISSISSIPPI.

The Yallabusha is a small stream about 90 miles long. It has its source in Calhoun County, Mississippi, flows through Grenada and Le Flore counties, and unites with Tallahatchee River, about 3 miles above Greenwood, in forming the Yazoo River.

An examination was made by the United States in 1879, and the plan of improvement based thereon contemplated the removal of snags, sunken logs, leaning timber, etc., obstructing navigation from Grenada to the mouth, about 63 miles.

The original estimate was $7,000, but it was found that additional funds would be required from time to time for removal of new obstructions caused by caving banks, etc.

An examination of the river above Grenada was made in 1882, but it was found to be narrow, shallow, and much obstructed, and not considered worthy of improvement. The Illinois Central Railroad bridge and a highway bridge crossing the river at Grenada are barriers to navigation above that point.

The improvement was begun in 1881 and continued during 1882, 1883, and 1884; resulting in making the stream navigable for five or six months of the year, or at high stages of water.

The snagboat *Meigs*, P. R. Starr master, commenced work March 17, 1887, and continued until April 10, when it was suspended by exhaustion of funds.

Operations extended from the mouth up-stream about half way to Grenada. The following obstructions were removed:

Snags pulled	number..	42
Stumps pulled	do....	167
Shore snags cut	do....	2,120
Leaning trees cut	do....	12,425

No steamboats ply in this stream at present, and the commerce amounts to little or nothing, but steamboat men say that the trade will begin if the river be cleared to Grenada. The work is of a kind best done by chopping parties. There is depth enough for large boats in high water, but leaning timber prevents passage at such times.

I recommend that $6,000 be expended in one season, starting with a party of fifteen or twenty men at low water, from Grenada, and removing everything on the way down stream. All heavy timber should be cut up and removed from the banks, to prevent formation of snags.

No steamboats navigated the stream, and no reliable statistics could be obtained.

The former appropriations were—

By act approved March 3, 1881	$3,500
By act passed August 2, 1882	3,500
By act approved July 5, 1884	2,000
By act approved August 5, 1886	2,000
Amount appropriated to June 30, 1887	11,000
Amount expended to June 30, 1887	11,000

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,000
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000

U 15.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of this river are in Tippah and Union counties, in the northern part of Mississippi. It flows in a southwesterly direction until joined by Coldwater River, in Quitman County; thence in a southerly direction, and unites with Yallabusha River in Le Flore County, forming Yazoo River.

An examination was made by the United States and report submitted in January, 1879. The project based thereon contemplated the removal of snags, sunken logs, and overhanging timber obstructing low-water navigation below the mouth of Coldwater, a distance of 165 miles, and also the removal of the wreck of the steamer *Star of the West*, lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000. An additional examination was made in 1880 to obtain further information in regard to the river.

Work was begun in 1879 and continued during 1880, 1881, 1882, and 1884. Parts of the appropriations of 1880 and 1881 and the entire appropriation of 1882 ($10,000 in all) were expended above mouth of Coldwater to Batesville, as required by the appropriation acts. This portion of the river, however, was not included in the original estimate of cost. This work resulted in the removal of a large number of obstructions, and greatly increased the capacity of the river for navigation. Previous to improvement the river was navigable from the mouth of Coldwater to the Yazoo about six months of the year. Boats from the Yazoo were enabled to run to Sharkey's Landing, 100 miles above the mouth, the entire year, but rarely went above that point at any stage, as the amount of commerce was not sufficient to justify the expense of a longer trip.

The snagboat *Meigs*, P. R. Starr master, began operations December 1, 1886, but on account of high water was withdrawn December 27. The work was resumed May 11 and continued till June 10, when the boat having reached the mouth of the river, and the appropriation being practically exhausted, she returned to the Yazoo River, after having accomplished the following work between Sharkey's Landing and the mouth:

Snags pulled............number..	767	Jams removed...........number..	1
Stumps pulled ....do....	143	Side jams removed ....do....	4
Shore-snags cut ....do....	191	Leaning trees cut ....do....	2,727
Logs removed from channel.do....	6		

The water-wheel beam of the sunken steamer *Star of the West* was also pulled out. At least half of this wreck yet remains badly in the way, and can only be removed by means of a diver and explosives, with which the snagboat was not provided.

The river is now in better condition than ever before known, and the river men are well pleased with the work accomplished. Many dangerous obstructions yet remain, however, the removal of which would greatly benefit navigation. New obstructions are also continually forming, and no permanent improvement can be effected on this account.

The snagboat *Meigs* should be used a short time each year in this river, to remove the heavy snags, but the work of improvement should be done mainly by shore parties. The river was navigable to Sharkey's Landing the entire year. The estimates for the year 1889 are as follows

Meigs, 1½ months, at $2,200	$3,300
Shore-party, wages and subsistence, 5 months, at $1,200	6,000
Explosives, tackle, etc	400
Office contingencies and administration	300
	10,000

The former appropriations were:	
By act approved March 3, 1879	$6,000
By act approved June 14, 1880	9,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	3,000
By act approved July 5, 1884	3,000
By act approved August 5, 1886	3,500
Amount appropriated to June 30, 1887	27,500
Amount expended to June 30, 1887	27,385.26

Above mouth of Coldwater, $10,000; below mouth of Coldwater, $17,385.26.

Money statement.

Amount appropriated by act approved August 5, 1886	$3,500.06
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,385,20
July 1, 1887, amount available	114.74

Amount (estimated) required for completion of existing project........	$22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the calendar year 1886 about six steamboats, drawing from 16 to 20 inches light and 4 to 5 feet loaded, with tonnage of from 50 to 250 tons each, plied in the stream, carrying the following freights:

Cotton	bales..	10,000
Cotton seed	tons..	3,000
Staves	number..	25,000

Return freights of general merchandise and plantation supplies; estimated value, $220,000.

U 16.

IMPROVEMENT OF STEELE'S BAYOU, MISSISSIPPI.

This bayou has its source in Swan Lake, Washington County, Mississippi, flows in a southerly direction parallel to the Mississippi River, and enters Yazoo River about 12 miles above its mouth, and generally is not navigable except when the Mississippi is high enough to fill the lower portion with backwater.

An examination was made by the United States in 1880, but no estimate of cost of improvement was submitted by the engineer officer in charge, who reported the stream not worthy of improvement, and the work not a public necessity. His assistant, who made the examination, reported the probable cost at $14,960.

The upper part of the bayou and the borders of Lake Washington and Swan Lake furnish the products shipped through it. The lower portion is subject to overflow from backwater, and not much land in the vicinity is under cultivation. The west side of Lake Washington is not far from the Mississippi River, and a branch of the Louisville, New Orleans and Texas Railroad extends from Greenville south to near the Issaquena County line, whence it will probably be continued to the main line near Rolling Fork. This is located between Swan Lake and Lake Washington, and will no doubt absorb much of the carrying trade that otherwise would be tributary to Steele's Bayou.

The work heretofore done was carried on in 1884-'85, and consisted in the removal of the principal obstructions only. A chopping party began operations at the foot of Swan Lake and continued down-stream to the mouth. After reaching Murray's Ferry, about 44 miles above the mouth, the water had reached such a high stage that the work below had to be confined principally to cutting leaning trees. The removal of obstructions by this party benefited high-water navigation considerably.

As the appropriation of August 5, 1886, included Washington Bayou, work was begun at the head of this stream, which connects Steele's Bayou and Lake Washington, on November 1, 1886, and continued down Steele's Bayou until the early part of January, when, the water having reached a stage too high for efficient work, operations were suspended. J. I. Mulholland was the superintendent in charge. The work extended over a distance of about 40 miles, and the following obstructions were removed:

Snags removed ....number..	198	Jams removed ....number..	17
Stumps cut ....do....	88	Leaning trees cut ....do....	708
Shore-snags cut ....do....	311	Leaning trees topped ....do....	190
Logs removed from channel ..do....	435	Brush and willows cut ....sq. yds..	280

I recommend that work be continued by the use of chopping parties and a small flatboat with steam capstan. The sum of $5,000 could be expended to advantage in cutting leaning timber and opening the bayou for high-water navigation.

No reliable commercial statistics could be obtained. It is presumed, however, that trade will increase, as the Delta is being more thickly settled and cultivation increased since the rebuilding of the levees on Yazoo front.

The former appropriations were:

By act approved July 5, 1884	$2,500.00
By act approved August 5, 1886	2,500.00
Amount appropriated to June 30, 1887	5,000.00
Amount expended to June 30, 1887	4,409.22

Money statement.

July 1, 1886, amount available	$5.26
Amount appropriated by act approved August 5, 1886	2,500.00
	2,505.26
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,914.48
July 1, 1887, amount available	590.78
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

U 17.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

This river has its source in Mud Lake, Coahoma County, Mississippi, flows in a southerly direction, and enters Yazoo River about 55 miles above its mouth. During extreme high water it is navigable to Clarksdale, 280 miles above the mouth. Faisonia, 144 miles above the mouth, is ordinarily considered the head of navigation.

An examination was made by the United States in 1878, and the plan adopted for the improvement consisted in building timber and brush wing-dams where necessary to scour a channel of from 3 feet to 40 inches depth over the bars, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of $66,000.

The improvement was begun in 1879, at which time but one boat, of 145 tons, and drawing 18 inches of water, navigated the stream. It was then navigable about six months in the year, but a boat could not make the trip under ten and often fifteen days. After the work of 1884–'85 it was not difficult to make a trip in six days at the lowest stages. Rates of freight and insurance had been reduced; a number of small settlements were springing up, mainly dependent on river transportation, and the commerce of the stream increasing about 10 per cent. annually. The improvement is not permanent, owing to sliding and caving banks and formation of new bars, and as no work has been done during the past two years, much of the good effects of former work is rapidly disappearing.

A preliminary examination was made in December, 1886, to obtain information as to advisability of commencing work, but owing to unfavorable stage of water and delay in obtaining a suitable steamboat, operations were not begun until June 14, 1887. The principal work required for immediate necessities of navigation being in the upper portion of the river, operations were pushed up-stream as rapidly as possible, removing obstructions and building and repairing wing-dams, where necessary, on the way. At the end of June the party had reached Rainy-Day Landing, 115 miles above the mouth, and succeeded in clearing the river so that steamboats could readily follow to that point. The following summary shows the work performed:

Snags pulled	No..	11	Logs removed from channel	No..	28
Stumps pulled	No..	1	Leaning trees cut	No..	70
Shore snags cut	No..	6	Wing-dams built	linear feet..	1,115

With the balance available it is proposed to continue operations according to the project until the appropriation is exhausted; applying $2,000 to the stretch between Woodburn and Lehrton, as required by the act. The wing-dams are expensive structures of brush and light sheet-piling, requiring no special plant, but adequate to the purposes for which built. Assistant Engineer W. S. Davis is in charge of this work.

The sum of $10,000 could be spent to great advantage in a single season in cutting leaning timber, removing logs from the channel, and building wing-dams. Two parties should be worked under the same superintendent, who has had experience in the kind of work to be done, and in handling explosives. The people engaged in business on this river want immediate relief, and work of a more lasting character than that of the past. Neither can be had with small appropriations.

The Georgia Pacific Railway Company obtained a charter for a bridge across the river near Johnsonville, Miss., by act approved March 3, 1887. Without waiting for authority of United States law, however, operations were commenced last winter, and the construction of the piers had begun when the matter was brought to my attention in May. I called the attention of the president of the company to the provision of the act and advised him to suspend work, which was done at once. Maps and plans are now being made as required by the law.

During the calendar year 1886 the river was navigable about eight months. Woodburn was the head of low-water navigation about four months, and Faisonia the head of high-water navigation about two months.

The former appropriations were:

By act approved March 3, 1879	$20,000.00
By act approved June 14, 1880	8,000.00
By act approved March 3, 1881	4,000.00
By act passed August 2, 1882	5,000.00
By act approved July 5, 1884	5,000.00
By act approved August 5, 1886	5,000.00
Amount appropriated to June 30, 1887	47,000.00
Amount expended to June 30, 1887	44,044.84

Money statement.

Amount appropriated by act approved August 5, 1886		$5,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,043.34	
July 1, 1887, outstanding liabilities	1.50	
		2,044.84
July 1, 1887, amount available		2,955.16
Amount (estimated) required for completion of existing project		19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Three steam-boats, of from 35 to 100 tons, and drawing from 8 to 18 inches light, and 22 inches to 3 feet loaded, made 99 round trips, carrying the following freights:

Cotton	bales	18,000	Hogs	head	2,500
Cotton-seed	tons	3,000	Wood	cords	2,000
Hides	pounds	25,000	Lumber (sawed)	feet B. M.	500,000
Staves	number	500,000	Timber (logs)	do	5,000,000
Cattle	head	1,500			

Return freights, general merchandise and plantation supplies.

U 18.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

This river has its source in northern Mississippi, flows in a northwesterly and then westerly direction through the most productive region of West Tennessee, and enters the Mississippi River at the junction of Lauderdale and Tipton counties, Tennessee, about 50 miles by river above Memphis.

An examination was made by the United States in 1879, and the project based thereon contemplates the removal of logs, snags, leaning timber, etc., obstructing navigation from Bolivar, Tenn., to the mouth, a distance estimated at 240 miles. This would render the river navigable for light-draught boats throughout the year. The original estimate of cost of this work was $30,000, but this was based upon a plan of four months work in 1880 at $15,000, three months in 1881 at $10,000, and two months in 1882 at $5,000. In place of this, appropriations aggregating $22,000 have been made at irregular intervals, scattered over a period of seven years, consequently increasing the cost and lessening the utility of the work done. In view of the present method of making appropriations, it is impossible to make any definite estimate for this class of work, as new obstructions are added from time to time, by the leaning timber and logs and snags brought into the stream by each flood.

This improvement was begun in 1880, and continued during 1881, 1882, and 1884. Before its commencement navigation was almost impossible. The work done has benefited commerce by allowing shipments by river, where previously railroads had a monopoly of the carrying trade.

Work was begun at mouth of the river October 15, 1886, and continued up-stream until January 15, when, the water having reached a stage too high for effective work, the party was disbanded at Rialto, about 60 miles above the mouth. After completing work in South Forked Deer River, that party and outfit were transferred to Big Hatchee River June 17. 1887, and beginning at Rialto worked back over the same stretch of river, reaching the mouth June 27.

Superintendent J. T. Dorey was in local charge of this work; during his absence on bayous Bartholomew and D'Arbonne, it was carried on under the supervision of William J. Morgan, overseer.

The following work was performed:

Stumps cut	number..	19
Shore snags cut	do....	807
Logs and snags removed from channel	do....	1,241
Jams removed	do....	2
Leaning trees cut	do....	3,813
Willows cut	square yards..	7,800
Stumps of piling cut at Chesapeake, Ohio and Southwestern Railroad Bridge	number..	26
Cut-offs cleared out	do....	3

This work was performed as thoroughly as possible with the available outfit, and resulted in giving a fair navigable channel from the mouth to Rialto.

The work should be continued up-stream from Rialto to Bolivar, paying particular attention to channel obstructions, which are more troublesome than leaning trees, much of the latter having been cut in previous years.

Part of this upper river will not require much attention, and probably none of it as heavy work as that performed in the lower river the past season. To thoroughly clear the river, a flat-boat, with necessary appliances for pulling snags and logs which are buried in the sand, will be necessary. The removal of these obstructions will enable the current to wash out and deepen the channel at shoal places, and would probably lengthen the navigable season at least two to three months each year.

The steamboat men and others interested in the navigation of this stream urge this method of improvement, stating that if the snags were thoroughly removed it would give 3 feet of water at the lowest stages, or navigation for light-draught steamboats the entire year. Were this done there is little doubt that the commerce of the stream would be much increased and freight rates of competing railroad reduced.

Complaint has been made of difficulty in passing the draw of the Chesapeake, Ohio and Southwestern Railroad Bridge at Rialto. The steamboat men would probably be satisfied with a sheer-boom on the up-stream side. As the stream is over 300 miles above Vicksburg, the office of this district, it is difficult to supervise the work, and expenses of administration are considerable. Economy would be subserved by expending sufficient in one season to put the river in so good a state as not to require work for several years.

It costs no more to get ready for six months' work than six weeks', and the expenses of administration are practically the same for both periods. The work will be much more thorough and the improvement more lasting by such concentration of effort, and the object arrived at—the practical benefit of navigation—more nearly attained.

I therefore recommend the expenditure of not less than $10,000 in one season, beginning work as soon as the stage of water will permit, constructing a flatboat, or hiring one if any can be found at or near Memphis, and using explosives liberally for removing snags and sunken logs. A shore party, lodged in tents and moved about in skiffs, should be used to clear the banks of brush and leaning timber, and to supplement the work in the channel, or to join with the flatboat party when the water is low.

During the calendar year 1886 the river was navigable for eight months. The Brownsville Bridge was the head of low-water navigation for four months, and during the remaining four months it was navigable to Bolivar.

Until this year commerce has been confined principally to timber rafts and stave barges, but now one steamboat is beginning to build up a trade, and others will probably follow. The railroads have taken advantage of the past condition of the river, and their rates from Covington and Rialto are more than double steamboat rates to Memphis.

The estimates are as follows:

Construction of boat, or hire for six months, at $300	$1,800
Wages and subsistence of channel and shore parties, six months, at $1,250	7,500
Explosives, repair of tackle, tools, etc	300
Office, administration, and contingencies	400
Total	10,000

The work can be carried on in connection with that on South Forked Deer River, so far as regards purchase and delivery of supplies and inspection.

The former appropriations were:

By act approved June 14, 1880	$10,000.00
By act approved March 3, 1881	3,500.00
By act passed August 2, 1882	3,000.00
By act approved July 5, 1884	2,500.00
By act approved August 5, 1886	3,000.00
Amount appropriated to June 30, 1887	22,000.00
Amount expended to June 30, 1887	21,935.46

Money statement.

July 1, 1886, amount available	$233.44
Amount appropriated by act approved August 5, 1886	3,000.00
	3,233.44
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,168.90
July 1, 1887, amount available	64.54
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Five small stern-wheel steamers made about seventeen trips into the stream. The quantities of freights reported by steam-boatmen are as follows:

Cotton	bales	5,000
Cotton-seed	tons	250

About 500,000 staves, 1,000 cords of wood, and 3,000 saw logs were also boated and rafted out of the stream.

U 19.

IMPROVEMENT OF SOUTH FORKED DEER RIVER, TENNESSEE.

This river heads in McNairy and Henderson counties, Tennessee, and, flowing in a general northwesterly direction, joins the main Forked Deer River 8 miles below Dyersburgh, Tenn. The commerce of the country through which it passes is considerable, and before the introduction of railroads was carried upon this stream to the Mississippi River. Of late years, however, the railroads have diverted the transportation of a large portion of the products in other directions.

An examination was made by the United States in 1880, and the project for the improvement contemplated the removal of snags, logs, leaning timber, and similar obstructions to navigation, from Sharon to the mouth (about 114 miles), at an estimated cost of $19,250. Operations, however, have been carried up to Jackson, Tenn., the head of navigation, 81 miles above Sharon. Work was carried on during 1883 and 1884, and a large number of obstructions, principally overhanging timber, removed between the mouth and Jackson, greatly increasing the facilities for navigation.

October 27, 1886, operations were begun at the mouth, working upstream. With the exception of ten days' delay from November 25 to December 5, caused by a sudden rise of the river, the work was continued with but little interruption until January 22, when high water rendered its suspension necessary. On the 11th of April it was resumed and continued up-stream to a point 3 miles above Cherryville and 4 miles below the Louisville and Nashville Railroad Bridge. After reaching this point the party turned back, working down-stream to Yellow Bluff, which place was reached June 16. This being the most convenient point for transporting the outfit, and the available funds being practically exhausted, the party was transferred to Big Hatchee River.

This work, in connection with that on Big Hatchee River, was carried on under Superintendent J. T. Dorey; during his absence on Bayous Bartholomew and d'Arbonne, Louisiana, William J. Morgan was the overseer in local charge.

The following is a summary of the work performed:

Stumps cut	number..	426
Shore snags cut	do....	3,223
Logs and snags removed from channel	do....	2,582
Jams removed	do....	7
Side jams removed	do....	29
Leaning trees cut	do....	6,253
Willows and brush cut	square yards..	19,757

This work extended over about 130 miles, from the mouth to 4 miles below Bell's Depot. The party, averaging about 12 to 15 men, moved about in a small flatboat, working in skiffs and upon the banks, removing the obstructions with axes, saws, and small blocks and tackle. The river was at a good working stage the greater part of the season, and the channel was cleared as thoroughly as possible with the means available. This part of the river is now in a fair navigable condition, much better than that of the main Forked Deer River, through which boats must pass to reach the Mississippi; and until something is done to improve this outlet further work will be of little advantage.

The following principal obstructions yet remain in the river and seriously obstruct navigation at all stages:

(1) *A log boom*, at Hosier Saw-mill, about 100 miles above the mouth and 3 miles below the Chesapeake, Ohio and Southwestern Railroad

Bridge. This is an arrangement built of piles for catching saw-logs, and although a space 50 feet wide has been left for passage of boats, it is inconvenient and unsafe. It should be removed entirely, or at least the opening should be enlarged until boats can pass without danger or delay.

(2) *An old railroad bridge*, at the crossing of the Brownsville and Paducah Narrow-gauge Railroad, about 108 miles above the mouth. This consists of several rows of piling, some of which have been cut off at low water.

The entire obstruction should be removed. The bridge is no longer used.

(3) *A county bridge*, at the crossing of the Brownsville and Alamo wagon-road, about 114 miles above the mouth. This is only 23 inches above high-water mark, and should be changed to a draw-bridge.

(4) *A brush dam*, about 8 miles below Bell's Depot and 130 miles above the mouth. This should be removed entirely, as it deflects the main body of the river into an artificial channel for use of private parties. This obstruction is built of brush and logs, and extends entirely across the stream. It is 201 feet long, averages about 15 feet in width, and is 2 feet above low water. It was built during the years of 1835 to 1840 by William Horsely, the owner of what is now known as Williams Mill. At that time the country for 30 miles around was dependent on this mill for grinding grain, and the dam and a canal to a slough 100 yards from the river were built by a general contribution of labor, to give a better water supply to the mill, which is located on this slough 3 miles below. The legislature of Tennessee passed an act in 1846 declaring the South Fork of Forked Deer River a navigable stream, and requiring the removal of dams and other obstructions. No attention seems to have been paid to this, and the mill was afterwards leased, and the canal enlarged and height of dam increased by the lessee.

On January 10, 1850, *ten years after the dam was built*, the legislature of Tennessee passed an act authorizing William Horsely *to erect a dam*, "provided that said dam should not be higher than low-water mark, and should not obstruct or impede the navigation of said river." This act also authorized him to raise the wings at each end of his dam higher than low-water mark, but directed that he should "leave sufficient space between said wings to admit any boat or other water-craft to pass through with safety and without being obstructed." After obtaining this authority Horsely sold the mill and water privilege. At present the dam is of little benefit to any one, and the mill is about ready to fall down and will be deserted before many years.

The people no longer use it, and are anxious to have the dam removed. The timber interest above the dam is sufficient to justify its removal, and at present it is hazardous to undertake to float down stave boats or timber rafts.

(5) *The Louisville and Nashville Railroad Bridge*, near Bell's Depot, 142 miles above the mouth.

This is a pile-trestle, and should be replaced by a pivot-draw. Between the piles which support the bridge are the stumps of a double row of piling, which should be entirely removed.

The above obstructions were re-examined during the past season by the superintendent in charge.

In addition to these, there are the following obstructions above the point where the past season's operations stopped. These were reported on in 1884, and if any changes have been made in their structure since, no notification of same has been received, but it is probable that they are as then reported, viz:

(6) *A county bridge*, 145 miles above the mouth. This should be changed into a draw-bridge.

(7) *An old county bridge*, at Poplar Corner, 160 miles above the mouth. This should be removed, being no longer used.

(8) *A county bridge*, at Campbell's Landing, 191 miles above the mouth. This should be changed to a draw-bridge.

(9) *A county bridge*, at McClannahan's Landing, 194 miles the mouth, and 1 mile below Jackson, the head of navigation. This should be changed to a draw-bridge.

It is recommended that future appropriations for this stream include the main Forked Deer River, about 29 miles long, and the North Fork. Report on examination of the latter is forwarded herewith. The present obstructed condition of the former prevents any navigation of the South Fork for at least three months of the year.

To do the work thoroughly requires a crane-boat, with steam-power and quarters for crew; a flat-boat, with hand capstan, quarters, and capacity for stores, outfit, tools, etc., and a liberal supply of explosives. The North Fork should first be entirely cleared of all obstructions, shore-work on the South Fork being carried on at the same time, and then the main river to its junction with the Mississippi; the shore parties preceding the craneboat.

A single appropriation of a reasonable amount would enable the officer in charge to conduct the work systematically and give practical benefit to navigation in one season. Little relief can be obtained with small amounts, unless given regularly each year in time for low-water work. Even under the most favorable conditions it must not be expected that work of this kind will be permanent, but if done well once the interests of navigation will not suffer greatly by the omission of appropriations for several years, and less amounts would be required afterwards for removing new obstructions. With small and intermittent appropriations the work may run on indefinitely. According to the estimate made in 1880 for South Fork, $9,250 would be required to complete the temporary improvements to Sharon, but operations have been carried 81 miles beyond, to Jackson, Tenn., though by no means thoroughly. With a single appropriation, however, I think the sum will be sufficient. Add to it the amount estimated for North Fork to Dyersburgh, $4,500, and about $7,000 for the main river, the whole can be done in one season, according to the following estimates:

Construction of crane-boat, with steam-power, quarters, etc	$4,600
Hire of flat and quarter boats, six months, at $400	2,400
Wages and subsistence of crew and shore parties, six months, at $1,800	10,800
Skiffs, tools, tents, tackle, etc	800
Explosives, batteries, fuses, wire, etc	800
Office, administration, and contingencies	600
Total	20,000

At present commerce is carried on only during high water, consisting chiefly of cotton and staves, which are brought out on barges. Large quantities of timber are rafted yearly to the saw-mills along the banks. No steamboats navigated the stream during the year, and most of the products were shipped by rail. Full and detailed statistics could not be obtained.

The former appropriations were:

By act passed August 2, 1882	$3,000.00
By act appproved July 5, 1884	2,000.00
By act approved August 5, 1886	5,000.00
Amount appropriated to June 30, 1887	10,000.00
Amount expended to June 30, 1887	9,882.76

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	4,882.76
July 1, 1887, amount available	117.24
Amount that can be profitably expended in fiscal year ending June 30, 1889	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

U 20.

WATER-GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

By joint resolution of Congress approved February 21, 1871, the Secretary of War was directed "to have water-gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in vicinity of" certain specified points.

During the fiscal year daily observations have been made at the following stations: Saint Louis, Mo.; Cairo, Ill.; Memphis, Tenn.; Helena, Ark.; mouth of White River, Arkansas; Lake Providence, Louisiana; Vicksburg, Miss., Natchez, Miss.; Red River Landing, Louisiana; Baton Rouge, La.; and Carrolton, La., on the Mississippi River; Fort Leavenworth, Kans., on Missouri River; Louisville, Ky., two (head and foot of falls), on Ohio River; Florence, Ala., on Tennessee River; Nashville, Tenn., on Cumberland River; Jacksonport, Ark., on White River; Little Rock, Ark., on Arkansas River, and Alexandria, La., on Red River. These gauges were established by Maj. Wm. E. Merrill, Corps of Engineers, during the latter part of 1871, except Carrollton, La., established January, 1872, and Nashville, Tenn., August, 1873. Observations were commenced at each station as soon as the gauge was established and have been continued regularly since, so that a complete record of daily readings at all the stations (with a few exceptions) has been obtained from January, 1872, to the present time. In 1881 bulletin-boards were erected at all stations on the Mississippi, for the purpose of giving to steam-boats the stage of water each morning.

The old gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, and the one belonging to the Missouri River Commission used in its place; payment for observations being made by this office, and the inspection and repairs continued by the Commission. To secure greater uniformity and accuracy, on February 1, 1887, the observers began reading the gauges twice a day, at 8 a. m. and 4 p. m.; formerly they had read at 8 a. m. only. On the Mississippi, the bulletins posted for the benefit of pilots and others have been changed to correspond with each reading. This additional service of reading and reporti the gauges and posting bulletins was secured without increased expense to the United States. A gauge bulletin was established at Alexandria, La., April 13, 1887.

By arrangement with the secretary of the Mississippi River Commission, Assistant Engineer John Ewens inspected and repaired gauges as follows:

November, 1886.—Inspected Red River Landing, Natchez, Baton Rouge, and Carrollton. Repaired Red River Landing and Carrollton.

January.—Inspected Cairo, Louisville, Nashville, Florence, and Memphis. Repaired Memphis.

February.—Inspected Little Rock, Helena, mouth of White River, Lake Providence, Natchez, Red River Landing, Baton Rouge, Alexandria, and Carrollton. Repaired Little Rock, Lake Providence, Natchez, Red River Landing, and Baton Rouge.

March.—Inspected Saint Louis, Cairo, Louisville, Nashville, Florence, Memphis, Little Rock, Jacksonport, Helena, and mouth of White River. Repaired Little Rock and mouth of White River.

April.—Inspected Lake Providence, Natchez, Red River Landing, Baton Rouge, Alexandria, and Carrollton. Repaired Red River Landing.

Early in June Assistant Engineer C. W. Clark, under the Secretary of the Mississippi River Commission, began an inspection to include all the gauges. At the close of the month he had inspected Cairo, Memphis, Helena, mouth of White River, Lake Providence, and Vicksburg gauges, and repaired those at mouth of White River and Lake Providence.

Many of the bulletins had become defaced and illegible, and were repaired during the year. They all need thorough overhauling, new frames, etc., and those on the Mississippi River should be made much larger.

Records of the daily readings of the gauges have been furnished the Mississippi River Commission, and a copy of the Carrollton gauge record has been furnished the assistant engineer in local charge of the examination and survey of South Pass of Mississippi River.

The gauge at Memphis was the only one which exceeded the highest water previously recorded, reaching March 9 and 10, 1887, 35.30 feet, the water of 1882, the highest prior to this, being 35.15 feet.

The amount heretofore allotted for these gauges is not sufficient for the purpose. The value of the records depends both on the accuracy of readings and the accurate location of the gauges themselves. The gauges should be checked frequently by reference to established benches, as even those which are called permanent are subject to motion from the unstability of the banks. An inspector should make a complete tour every month, with level and rod and appliances for minor repairs. Nearly all of the permanent gauges will require to be rebuilt, and all the bulletins repaired and painted. Bulletins should be erected at stations on the tributaries not provided with them.

Reports are received weekly at this office, and, after review, consolidated and sent to the secretary of the Mississippi River Commission for revision and publication. As the amount appropriated is not sufficient to pay for a special clerk for the work in this office, and as the work has to be revised by the secretary of the Commission, I think it would be more satisfactory and more economical to transfer the whole business to that officer.

The amount remaining on hand after June 30, 1887, will barely suffice for payment of keepers and services of inspection to October 31.

The hydrographs have therefore been omitted, and will have to be put off till a sufficient amount be allotted for this work.

There will be required for continuing observations, pay of gauge-keepers to June 30, 1888	$3,200.00
And for assistant engineer to inspect the gauges, traveling expenses, minor repairs, clerical work, stationery, and hydrographs	3,500.00
	6,700.00
The amount on hand July 1, 1887, is	1,628.92
Deficiency for 1887–'88	5,071.08
The amount required for keepers' wages for 1888–'89 will be	3,200.00
Pay of inspector	1,500.00
Traveling expenses	1,500.00
Rebuilding gauges, repairing bulletins, new bulletins, and clerical work, stationery, and hydrographs	1,300.00
Total	12,571.08

The resolution of 1871 seemed to be intended to provide an appropriation of $5,000 every year without further legislation. If the amounts called for as above be given, the gauges can be put in good shape, and the amount required for average repairs kept low. If $6,000 were given every year it would probably suffice, by distributing part of the expenses of inspection between this office and the officers in charge of districts on the Mississippi River.

After the funds become exhausted the keepers will probably agree to continue observations, with the expectation that an appropriation will be made for pay during the time of voluntary service.

Money statement.

July 1, 1886, amount available		$251.14
Amount appropriated by act approved August 6, 1886		5,000.00
		5,251.14
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,609.92	
July 1, 1887, outstanding liabilities	12.30	
		3,622.22
July 1, 1887, amount available		1,628.92
Amount that can be profitably expended in fiscal year ending June 30, 1888		6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

U 21.

PRELIMINARY EXAMINATION OF OUACHITA RIVER, LOUISIANA, FROM CAMDEN TO MOUTH, WITH A SLACKWATER NAVIGATION.

A survey of Ouachita River from Arkadelphia to the mouth was made by Lieutenant-Colonel Reynolds in 1871. In 1874 Major Benyaurd made a resurvey from Camden to the mouth of the river, and submitted estimates for dams with locks of stone or timber, the cost rising from about $3,000,000 to $6,000,000. Major Miller made further examinations in

1882 and 1883. (Reports of Chief of Engineers, 1871, page 340; 1874, part 1, page 352, and 1884, page 1386.)

Major Benyaurd's project was abandoned shortly after its approval, as the cost was considered too great in proportion to the amount of commerce to be benefited.

Some $20,000 had been expended for timber for beginning the foundation of three locks, which had to be sold at public auction in accordance with existing law. The net proceeds, somewhat less than $900, were turned into the Treasury.

Since the plan was abandoned, the Missouri Pacific and Cotton Belt routes have been completed southward, joining at Texarkana, and lines have been pushed westward from the Mississippi River, from Arkansas City and from Natchez, the former nearly to Camden and the latter to Black River.

The line from Vicksburg to Shreveport, crossing Ouachita at Monroe, has been greatly improved; and a line has been projected to run parallel to Ouachita River and to tap cross-lines as far south as Alexandria, La. Two other lines have been located by different parties. One to touch the bends and lakes west of the Mississippi, and the other to follow in general the higher grounds, known as the Maçon Hills.

It is very difficult to make estimates of the amount of commerce on the river, but from such information as I have been able to obtain it does not appear to be increasing, and will probably remain at a stand until the dangers from overflow have passed. Allowing fair market rates for the cotton estimated to have been carried down Ouachita River during the fiscal year, the down freights amount to about $4,000,000 in value, and the return to about $3,500,000.

Major Benyaurd considered the bar at the mouth of Red River the key to this project, and the objections that he offered in 1874 have equal force at the present time. Three feet cannot be carried over that bar at low water without dredging and scraping. Indeed it is not to be doubted that Red River would divorce itself from the Mississippi in a very short time if work on the bar were abandoned.

I made an examination of the river from Monroe to Camden in March—river at about 20 feet on the gauge. I saw two small steam-boats and one larger one during the trip, which occupied about five days. Most of the river commerce is carried on by boats from New Orleans, which draw from 2 to 4 feet light, and from 5 to 8 feet when heavily loaded.

Taking into consideration the time of year when business is remunerative and the stage of water favorable, I think the present system of removing snags, leaning timber, etc., by the aid of plant belonging to the United States, all that should be attempted. With sufficient money in one appropriation to give a good season's work to the snag-boat *Wagner*, and to provide for a crane and quarter-boat for a river and chopping party to work between medium stages and extreme low water over the whole river, as recommended in my report on Ouachita River for 1887, the stream could be put in excellent condition. Brush or timber wing-dams could be built at the shoals, especially below Monroe, with but little expense, the material removed from the adjacent banks being used for the purpose. No special estimate is made for this stretch of river, the amount required being included in my general estimate for Ouachita River for 1888–'89.

In my judgment, Ouachita River is not worthy of improvement by locks and dams, and the work is not a public necessity.

No further examinations or surveys are considered necessary.

U 22.

PRELIMINARY EXAMINATION OF CORNAY RIVER, LOUISIANA.

This stream was examined by Major Miller in 1883, in connection with Bayou D'Arbonne, which it joins at Farmerville, La. (Report Chief of Engineers, 1884, page 1376.)

Assistant Engineer W. S. Davis made an examination of the Cornay in February, 1887, beginning at Shiloh Landing, the shipping point for Shiloh, a village of some 300 inhabitants, about 4 miles from the river. Cornay is not navigable except during high water, or about five months in the year. It is practically dry in low water, and about 30 feet deep in extreme floods.

The principal obstructions are cypress stumps and leaning timber. It would cost at least $8,000 to clean the river from its junction with D'Arbonne to Shiloh Landing, say 16 miles, and the benefit would consist only in reducing the haul from Shiloh to the river from 8 to 4 miles.

It is reported that 850 bales of cotton were shipped from Shiloh last year, and about 4,000 bales from Stein's Bluff.

Work was done during the autumn and winter on D'Arbonne, and if continued may give sufficient relief to the country about Shiloh. I do not think Cornay River worthy of improvement at the present time, or that the work is a public necessity.

No further surveys or examinations are considered necessary.

U 23.

PRELIMINARY EXAMINATION OF DUGDEMONA RIVER, LOUISIANA.

This stream was examined by Assistant W. S. Davis in March, 1887. He reports that it is only a tortuous creek, flowing through an uninhabited swamp about 2 miles wide. The surrounding country is hilly and sparsely settled, and the soil is thin.

The stream is used to a limited extent in rafting stave timber into Little River, and thence through the lower end of Catahoula Lake and Saline Bayou into Red River. To the northward the country around Winnfield is under cultivation, and produces a certain amount of cotton estimated at not over 2,000 bales. This is hauled to Ouachita River for shipping.

Some years ago, it is said, a small steamboat ascended the stream nearly as high as Winnfield, but could not find a place to turn around. She was compelled to back out, and barely escaped loss, the upper works being carried away by leaning timber during the passage downstream.

Assistant Davis does not find any argument in favor of improving Dugdemona River, and I therefore conclude that it is not worthy of improvement; that the work is not a public necessity, and that no further examination or surveys are needed.

U 24.

PRELIMINARY EXAMINATIONS OF THE LAKES CONNECTING WITH RED RIVER, BETWEEN SHREVEPORT, LOUISIANA, AND FULTON, ARKANSAS; ALSO CLEAR LAKE, BLACK BAYOU, RED BAYOU, BLACK LAKE, AND KELLEY BAYOU, TO REOPEN NAVIGABLE COMMUNICATION BETWEEN THOSE STREAMS AND RED RIVER, LOUISIANA.

These waters are classed together because nearly all have a common origin. They are chiefly the remains of overflows caused by the raft, and of by-passes or canals made during the raft period for high-water navigation around the obstructions to Upper Red River.

In 1872 Congress began to appropriate funds for removing the raft in order to make the navigation of Red River free, and on this work alone nearly $500,000 has been spent to the present time upon the line selected for Red River by the engineers in charge. This work is still going on, and will not be completed until the obstructions are removed to such a depth as to enable the river to recover its normal slope. During the progress of this work the lakes, by-passes, and canals have been filling up, or have been closed to some extent by dams, to confine the water to the main line at medium or high stages. (Reports of Chief of Engineers, 1882, page 1546; and 1885, pages 1473, 1475.) The low-water surface of the river has been lowered, how much it is impossible to determine for want of accurate levels before 1872, but it is safe to say by *many feet*. The slope will continue to diminish as the work progresses and the bottom scours, and the high-water line will naturally follow in proportion, thus reducing the danger of overflow.

To give some idea of changes that have taken place in Upper Red River since the work was undertaken systematically under Major Howell, I mention Silver Lake, on the right bank, immediately below Shreveport. Within the past few years this has drained naturally, has been cleared, and is now all under cultivation. A more striking proof of the reduction of the low-water slope is to be found in the reaches above Shreveport, for example, between Pandora and Shady Grove, about 15 miles above, where the obstructions known as the Dawn Stumps exist. These, some hundreds in number, are thickly planted in and along the channel for a mile or more, projecting above low water, some as much as 6 feet. They look like large piles driven at random and cut off without regard to the water surface. Formerly boats went over them, but as the low-water surface fell passage had to be made by dropping through by the aid of lines, and at last had to be given up except at high stages. These obstructions have been worked over for some years without much success. Last year at low water those in mid-channel were cut off as near the water surface as possible, and sign-boards and gauges were set up to indicate the depth over them for safe passage.

This year, at the *same stage*, the stumps that were cut off were found to project above the surface from 4 to 5 feet, and many more appeared which before had not indicated themselves by a ripple. Work is now being done with high explosives to remove them down the roots, and this must result in a greater scour in this reach than has yet occurred.

The survey provided for in the act of August 5, 1886, has been carried as far as Shreveport. According to instructions accurate levels were taken, and all outlets and inlets examined, and the principal ones followed out for at least 2 miles. The profiles show that the low-water slope in the Raft district is still far above the normal, and that a reduction in the elevation of low water of nearly 8 feet may be expected without materially affecting extreme low water at Shreveport. The profiles show a like reduction in the high-water slope. It must continue to diminish until the river becomes normal. When this condition is reached it is not probable that Red River will overflow its banks unless obstructed by log-jams below, or by bars caused by dissipating the waters of the main river through outlets. The natural result of improving the main river has been, and will continue to be, the drainage of side channels and lakes. Every connection, especially at stages below high water, which might form an outlet from Red River should be closed. No attention need be paid to the inlets. If they happen to lie in the way of State levees they will be cut off, and the water derived from the small amount of natural drainage will be retained or find an outlet below.

Some of the high-water outlets from Red River have been closed, others are filling naturally as the river scours, and others are being used as places for depositing logs and stumps taken from the channel near by. This work will probably be completed by the State, it being the intention to restore the old line of levee on the right bank. It is probable that the gap in the levee on the left bank will be closed also, though the necessity does not seem to be very pressing, by reason of the reduction of the flood-line to which I have referred. The State engineer and his assistant have examined the line, and are now engaged in obtaining information from the notes of the recent survey from Fulton to Shreveport, with the hope of avoiding the expense of resurveys and separate lines of levels.

These levees would be worse than useless if the outlets were to remain open, but as it can hardly be doubted that the State authority is supreme in this matter, especially as many of the outlets were canals built under State law, and none are navigable now. The clearing of the outlets seems a foregone conclusion, and the lakes and bayous under consideration must find escape into the main river below, if at all.

Again, the United States have spent a large amount on the improvement of Upper Red River, and will doubtless continue to spend considerable sums upon this work for many years to come. To hold what has been gained requires that all outlets from Red River should be closed. To "reopen" the abandoned canals and bayous to improve the navigation of these "overflow" lakes would be to fritter away the labor of years. There is but one case in which "outlets" are proper, and that is in the improvement of a tidal stream subject to destructive freshets from the non-tidal portion. The subject has been exhausted in discussing the Lake Borgne scheme, and need not receive further attention.

Now, as to the streams in question: Most of those on the right bank are given on the map printed with Ex. Doc. No. 103, House of Representatives, Forty-eighth Congress, second session; those on the left bank were surveyed for a greater or less distance, in connection with the recent survey of Red River, but the maps have not been developed for want of funds. On the left bank the last of the by-passes extends from Stanton's Slough down to the mouth of Posten Lake, at Miller's Bluff, a distance of about 12 miles due north and south. This was a steam-boat route during the Raft period, and was entered at two or three places besides the ends, as at Alban's Canals, Nos. 1 and 2. This passage is entirely closed. The lake does not connect with Red River by any passage above. It is similar to Lakes Bodceau, Bistenau, and the Dorcheat, which connect with Red River below Shreveport, for which one appropriation was made, in 1884, contrary to the recommendations of the engineer in charge, and which has not been recommended to be continued. I have not been able to discover the existence of any commerce on this lake, nor have I heard of any desire on the part of steamboat men for improving its navigation. No water can go into it except from natural drainage or from backwater from Red River when the latter is high.

There are two or three other lakes below Cauchatta and Carolina Bluffs, which derive their waters from overflow. There is no navigating them.

On the right bank there is a connected lot of bayous and ponds extending from the Arkansas line to Shreveport, a distance of about 36 miles north and south. The waters drain into Red River through bayous and the Sodo Lakes, the latter forming part of the high-water route to Jefferson, Tex. The upper connection with Red River used to be through Half Moon Lake, Kountz's, Sale and Murphy's, and Hervey's canals, and also through Simpson's Lake and Red Bayou, either by the foot of Cypress Brake, which is also called Black Lake, through Kelley Bayou or by Sewall's Canal and Black Bayou into Clear Lake. There were two other connections from Red River at high water through Elmer's Bayou and the canal and Dooley's Bayou. All united at the foot of Clear Lake, whence the way led into the Sodo Lakes through Stumpy Bayou. After the way was cleared there was a high-water route from the Sodo Lakes to Red River by way of Twelve-Mile Bayou to Shreveport.

Red Bayou is a name given to many of the outlets or inlets to Red River. There are four of them in the small district above Shreveport. The principal one is about 6 miles above Gilmer, but as the bottom is somewhat above the river surface at ordinary low water, it does not receive any supply till Red River has risen considerably. At high water it is about 250 feet wide and 20 feet deep near the river, but its section is soon reduced by a dam of drift-wood about 300 feet long. There is another jam some 4 or 5 miles below, so that there is no flow of water until after the second jam is passed, the supply being obtained by percolation until the flood rises above the masses of drift. Below the second jam it enters Elmer's Bayou, the bottom of which is about 7 feet above low water at its junction with Red River.

Sewall's Canal joined these streams with Clear Lake by way of Black Bayou about 5 miles, thence to Stumpy Bayou about 5 miles more, and so through a cut called Grand Pass to the Sodo Lakes.

Dooley's Bayou joins Red River about a mile below Elmer's, opposite Cauchatta Bluffs. The bottom of this bayou is above ordinary low water. It was formerly closed by a dam on the line of levee, but the opening was *restored* by private enterprise. The new State levees will follow the old line generally, but will cross this bayou somewhat below the entrance. In the mean time, drift and snags are being forced in by the boats when at work near by, to form a jam that may help protect the levees and assist in closing the bayou. This bayou also connects with the Sodo Lakes through Sewall's Canal. There is a number of similar high-water outlets below, but none of them as large as Dooley's except Cottonwood, but all will be cut off by the levee. The last named is quite large at its junction with Red River, but soon separates into a number of drains, none of which are navigable. The fall is quite rapid. The levee and dam crossing it have been destroyed twice, the last time in 1884.

Black Lake and Kelley Lake are above Upper Red Bayou, and connect with Clear Lake and the Sodo Lakes through passes which take the names of Black and Kelley Bayous. They are of the same character as the others, and like them will soon have no supply except from natural drainage.

Red Bayou carries no water when Red River is low. It is about 100 feet wide in high water, but is obstructed by logs and overhanging trees.

Sewall's Canal and about 4 miles of Black Bayou are fairly navigable for very small craft at high water, but the last mile of Black Bayou is closed at all stages.

Clear Lake is shallow, practically dry at low stages, and overgrown with willows. Stumpy Bayou and Grand Pass could be cleared to the Sodo Lakes without much difficulty if it were worth while, but there can be no navigation through the lakes till the way is cleared on the route from Jefferson to Shreveport, and not then unless a channel should be dredged to meet it.

The natural drainage of this collection of lakes, etc., is not great, and as the inlets above are to be closed as outlets from Red River, opening navigation through them to connect with Red River below near Shreveport would, in my opinion, result in little more than draining them, an excellent thing for benefiting the lands near by and improving their healthfulness, but hardly to be obtained under the plea of improving navigable waters of the United States.

The water supply then must come from natural drainage and backwater from Red River at Shreveport. Taking low water at the latter as zero a rise of 12 feet will just reach the head of the Sodo Lakes; 25 feet will barely reach Sewall's Canal; and maximum high water will not reach the foot of Upper Red Bayou. At least 20 feet on the Shreveport gauge will be required to give a 3-foot navigation in Clear Lake.

It is evident that no navigable route can be made for low water, and that to give navigation at high water a dam and canal would have to be built at great expense. Major Howell submitted a project in 1874 for Cypress Bayou and the Sodo Lakes, which involved such construction at an estimated cost of about $400,000. This was rejected as being too great in comparison with the possible benefits that might accrue. Since that time the main line of Red River has been considerably improved, and railroad facilities have been increased very greatly. Two railroads cross Red River above; one at Fulton and the other at Garland, some 60 miles below, both meeting at Texarkana. A line passes to the west of the lakes at Jefferson, and four lines now center in Shreveport. A fifth line is being built from the cotton-belt route, east of Posten Lake and its tributaries, and will soon enter Shreveport by the present railroad bridge. The country would seem to be well supplied with means of transportation.

As to the amount of commerce that would be benefited by reopening the connection with Red River and the lakes, etc., I am unable to form any opinion. I cannot learn that there has been any call for such route by river men, or that there has been any navigation at all in the lakes on the left bank since the raft was removed; and that on the right bank was abandoned as soon as Red River proper was made navigable.

The products of the country about Clear Lake, Black Bayou, etc., were estimated last year at about 500 bales of cotton and 250 tons of seed, and it was thought that with Dooley's Bayou kept open the amount might be doubled. No reliable statistics could be obtained. On the other hand, the amount of commerce that would be injured would be the present and future trade of the improved portion of Red River above Shreveport.

After a careful examination of the subject I am of the opinion that none of these streams are worthy of improvement, nor are the works public necessities. No further surveys or examinations are necessary.

U 25.

PRELIMINARY EXAMINATION OF CYPRESS BAYOU, LOUISIANA.

The only Cypress Bayou that I have been able to find in this district lies in Texas, and forms with Fairy and the Sodo Lakes the high-water route to Shreveport. According to the early surveys, "the old channel of Cypress Bayou may yet be traced at low water" through these lakes, "and this, if cleared of logs and stumps, would afford low-water navigation of about 2 feet." Reports of the surveys and the final project for high-water navigation will be found in Reports of Chief of Engineers for 1873, page 669, and 1874, Part 1, page 706. The estimates called for $372,580 in a single appropriation, in addition to the amount then on hand or that might be required afterwards for removing obstructions from the bayou. This project was disapproved on account of its great cost. In the mean time work was carried on by dredging and removal of logs, stumps, leaning timber, etc., so that by 1880 there was a well-defined channel, marked with sign-boards, from Jefferson to Shreveport, a distance of about 65 miles.

A re-examination of this route was made in 1884, the report of which, with a map, will be found in House Ex. Doc. No. 103, Forty-eighth Congress, second session; and without the map on page 1552, Report of Chief of Engineers, 1885.

The sum of $94,000 had been expended on this work to June 30, 1886, and the act of August 5, 1886, appropriated $18,000 more "to complete improvement." With this amount the old dredge *Lone Star* has been rebuilt and the work begun. The amount remaining on hand July 1, 1887, will allow about fifteen months' work to be done.

A reconnaissance was made in September, 1886, by the superintendent formerly in charge of the work, and subsequently I visited portions of the route. No further surveys or examinations are considered necessary. For details, suggestions, and money statement, attention is invited to my report on Improvement of Cypress Bayou, Texas and Louisiana, for the fiscal year ending June 30, 1886.

U. 26.

PRELIMINARY EXAMINATION OF NORTH FORK OF FORKED DEER RIVER BELOW DYERSBURGH, TENNESSEE.

This stream was examined in 1873 by Major Suter, and again in 1880 by Major Benyaurd. (Reports Chief of Engineers 1874, page 375, and 1881, page 1492.) I had another examination made last autumn by Superintendent J. T. Dorey, who was in charge of the work on South Fork.

The distance from Dyersburgh to the junction of the two forks is about 9 miles, but the stream is very crooked. The principal obstructions are sunken logs and leaning and fallen timber. If these were removed the river would be navigable for small boats at any stage above 3 feet. If it is intended to continue the work of improving South Fork, North Fork should be cleared, and the work extended below their junction to the Mississippi River.

The amount of work required is very great, and no practical benefit would be given unless a considerable appropriation should be made in the beginning.

At least $4,500 would be necessary to make North Fork navigable to Dyersburgh, and $15,000 would be none too little for South Fork and the main river.

Superintendent Dorey reported the following obstructions in the 9 miles below Dyersburgh:

Sunken logs	1,000	Rack heaps	40
Leaning trees	950	Shore snags	400
Stumps in the water	250	Stumps on the bank	60
Channel snags	800	Points to be cleared in bends	20

Forked Deer River drains a thickly-settled and productive country. Dyersburg is the principal town and shipping point.

The amount of yearly shipments by rail was given about as follows:

Cotton	bales	20,000	Tobacco	hogsheads	100
Corn	bushels	70,000	Hay	tons	1,000
Potatoes	do	10,000	Shingles	number	500,000
Cattle	head	2,500	Laths	do	1,000,000
Hogs	do	6,000	Lumber	feet, B. M.	30,000,000
Peanuts	sacks	2,500	Timber	do	50,000,000

I think the stream is worthy of improvement and the work a public necessity, provided it be done in connection with a systematic improvement of the main river.

Estimates for the main river and both forks include the amount recommended for this part of the river, and are given in my report on South Forked Deer River for fiscal year 1887.

No further examination or surveys are necessary.

U 27.

PRELIMINARY EXAMINATION OF OUACHITA RIVER ABOVE CAMDEN, ARKANSAS.

A survey of Ouachita River from Arkadelphia, Ark., to its mouth, with plans and estimates for the improvement, was made in 1871 by Lieutenant-Colonel Raynolds.

The river was re-examined between Arkadelphia and Camden in 1883, by Major Miller, who reported that it was "not worthy of improvement nor a public necessity." (Reports of Chief of Engineers, 1871, page 340, and 1884, page 1351.)

I examined the river in March, 1887, between Monroe, La., and Camden, Ark., but did not continue to Arkadelphia, as the pilot was unwilling to take the United States snagboat *Wagner* above the railroad bridge at Camden, the gauge at that place reading 18 feet falling, and the boat drawing about 26 inches.

The agent at the Camden wharfboat stated to me that the business of the upper river, which consisted chiefly in lumber and staves, was over for the season, and that Camden was considered the head of navigation and was the principal shipping point for cotton.

In June, the water being low, Assistant Engineer H. St. L. Coppée made a skiff reconnaissance from Arkadelphia to Camden.

He found the river in about the same condition as described in Major Miller's report. The obstructions consist of shoals, crooked rapids over rocky ledges or compacted gravel, logs, snags, and leaning timber. At a stage that affords navigation to Camden the upper section is sufficient for small boats, so far as shoals or sunken logs are concerned, but it is much obstructed by leaning timber, especially in the bends, which becomes more dangerous as the water rises, as is the case with all similar streams in this district. To make this part of the river navigable for large boats in low water, or say at a stage 5 feet above, would not only require the removal of leaning timber but a system of locks and dams. Such a scheme would mean the expenditure of a large sum for construction and a considerable amount for maintenance, and to be of any practical benefit would require the system to be continued downstream to Red River.

Indeed, it may be said that a plan for slack-water navigation of Ouachita River would be of no value unless deep water were assured over the bar at the mouth of Red River.

It is impracticable to say what amount of commerce would be benefited by any improvement of Ouachita above Camden, for lack of reliable statistics.

It is stated that about 15,000 bales of cotton are shipped from Arkadelphia, that return freights amount to about $500,000 in value, and that about $500,000 worth of pine timber is shipped by the Arkadelphia Lumber Company. No records appear to be kept of the river freights. Since the first survey, the Missouri Pacific Railway system has been extended through Arkadelphia to Texarkana and beyond, the Cotton Belt route, now standard gauge, through Camden to the same place, and a line from Camden to Gurdon connects the two routes. A line is projected and partly built from Arkadelphia towards Camden, and but a short gap remains to be filled between Camden and Warren to connect with the lines to Arkansas City and Greenville.

I find nothing to recommend an expensive improvement of Ouachita River, either above or below Camden, but I think the river between Arkadelphia and Camden, some 90 miles, is as worthy of attention as the tributaries below Camden, such as Bayous Bartholomew and d'Arbonne and Saline River, in which considerable amounts have been expended. The work should be done thoroughly and in one season. It should consist in cutting leaning timber, girdling trees, removing snags and logs by dynamite, and building brush dams at the shoals. If the sum of $9,000 were granted in one appropriation, the river could be thoroughly cleaned in about four months, and should not require attention for many years. If small amounts should be appropriated the work would probably run along indefinitely. I recommend an appropriation according to the following estimates:

Labor, subsistence, superintendence, and administration expenses	$6,400
Flat-boat, outfit, and tools	2,000
Dynamite	600
Total	9,000

This amount may be considered as included in the general estimate contained in my report on Ouachita River for the fiscal year 1887. If the amount asked for therein can be given in a single appropriation, the only thing required will be to change the title to improving Ouachita River from Arkadelphia to the mouth. This would save the expense of organizing separate parties and the cost and trouble of rendering separate accounts for two stretches of the same river.

No further examinations or surveys are necessary.

U 28.

PRELIMINARY EXAMINATION OF CASSITY BAYOU, MISSISSIPPI.

This little stream, a tributary to Tallahatchee River, was examined by Captain Bergland in 1884, and considered by him as not worthy of improvement. (Report of Chief of Engineers, 1885, p. 1534.) Assistant Engineer Burrows reported that the improvement of Cassity Bayou was not practicable above Hopson's Bayou, but that it could be made navigable below for about seven or eight months in the year at an expense of about $200 a mile.

Assistant M. B. Lydon made another examination of the stream in January, 1887. He reported that the bayou from Shotwell's to Belen, about 30 miles, was made up of swamps and so-called lakes.

From Shotwell's to Hopson's Bayou, about 10 miles, the bayou varied in width from 35 to 70 feet, was filled with logs and stumps and obstructed by leaning trees.

There is one plantation in this section, Shotwell's, which ships about 400 bales of cotton. No land has been cultivated for 10 miles or so below Hopson's Bayou since the overflow of 1882.

From Buford's to the mouth, about 40 miles, the country is fairly settled, and if the new levees hold, will doubtless produce a large amount of cotton in a few years.

The bayou was cleared in 1860 by the planters interested at a cost of about $5,000, and no doubt the expenditure of a like sum would afford considerable relief.

If that sum could be had in one appropriation, it is probable that the bayou could be made navigable for small boats for about 50 miles from the mouth for about six months in the year.

The stream is as worthy of improvement as any of high-water tributaries in the district for which appropriations have been made heretofore. I therefore recommend an amount of work as above.

No further examinations or surveys are necessary.

U 29.

PRELIMINARY EXAMINATION OF BAYOUS RONDEWAY AND VIDAL, LOUISIANA.

These streams drain the country south of Milliken's Bend and east of Tensas River, the direction of flow depending on the relative heights of the Mississippi and Tensas. They were examined by Major Miller in 1883 in connection with Lake Palmyra, which they enter by a canal made some years since either by the State of Louisiana or by private parties, the State levee being cut for the purpose.

In view of the great cost of the work and the small amount of commerce that would have been benefited by improving these streams and the lake by which entrance was to be gained from the Mississippi Major Miller reported adversely. (Report Chief of Engineers, 1884, pp. 1347 and 1370.)

Assistant W. S. Davis made another examination of the bayous and lake in January, 1887, and I went over the greater part of the route in March. The conditions had changed very much since Major Miller's report, and both Mr. Davis's report and my own observations inclined me strongly to recommend the expenditure of $5,000 in a single appropriation for enlarging the canal and removing leaning trees and logs from the bayous.

I learned, however, that it was the intention of the State authorities to close Diamond Bend Crevasse this autumn by a new levee north of Lake Palmyra and several miles back of the old line, and so join the old levees west of the lake and south of Bayou Vidal. The Reid Crevasse below Delta Point and the breaks above Milliken's Bend will be closed this year, so that the bayous will be entirely cut off from the Mississippi River, and receive water only from Tensas when it is high and will run dry in low water.

Boats will still be able to enter the lake when the Mississippi is 30 feet at Vicksburg, and as the main river is caving rapidly on the right bank and cutting of the horns of the old bend, which now forms the lake, it is quite probable that there will be good navigation before long to the mouth of the canal at New Carthage at a much lower stage of the water.

In view of the facts stated above I do not consider bayous Rondeway and Vidal worthy of improvement or the work a public necessity. I recommend, however, that a single appropriation of $1,000 be expended in removing obstructions, chiefly leaning trees, from the canal and the part of Bayou Vidal which will remain open from the lake to the line of the proposed levee. This will give some relief to the people living on both bayous and near their junction, who must otherwise haul to the railroad on the north or to landings on the Mississippi below Davis's Cut-off.

The business of the calendar year 1886 amounted to about $750,000. There were 134 trips made by two small boats, 15 trips made by one boat of 450 tons, and 20 trips made by a steamer of 1,500 tons. The large boats could only go to the canal. In round numbers, 7,000 bales of cotton and 6,000 tons of cotton seed were shipped last year, besides wool, tallow, hides, neat cattle, hogs, timber, etc.

No further examinations or surveys are necessary.

U 30.

PRELIMINARY EXAMINATION OF LITTLE RIVER, LOUISIANA.

This stream is formed by Dugdemona and Bayou Castor. It flows into the low-lands which become Catahoula Lake in high water, and drains into Black River or Red River, according to circumstances. The water-way from the northeast of Catahoula Lake is also called Little River. It joins Ouachita and Tensas at Trinity, La., and forms with these Black River, which runs into Red River.

This stream was examined in March, 1887, by Assistant W. S. Davis in connection with Dugdemona. He made the trip down to White Sulphur Springs in a canoe, and thence to the mouth in a small steamboat.

The stream is about 100 miles long. For the greater part of its length, and as far as Catahoula Lake, it flows through a sparsely settled country, consisting mostly of swamps.

The current is sluggish and the width considerabe. In fact it is made up of pools, which would doubtless drain off if Saline Bayou or Catahoula Lake were opened for low-water navigation. Mr. Davis reports the business of the river to consist in logging; steamboats being necessary when the stream is filled by backwater or overflow. The amount of cotton shipped is less than 500 bales a year.

Catahoula Lake is a depression which fills from Dugdemona and Little rivers, or from overflow from Ouachita River and tributaries, through outlets at and above Trinity. At low water it is drained and becomes a meadow. The land to the northeast is called Catahoula Prairie. Saline Bayou, which connects this lake with Red River, has been cleaned for rafting timber, and if any work of improvement is required it should be on that line, the distance to market being about 100 miles less that way.

The stretch of river from the lake to Trinity lies in a more cultivated district. It is wide and deep enough to accommodate boats suited to the small trade, except for sunken logs, which become dangerous in very low water. If these logs were removed and the most obstructive leaning timber cut away, this part of Little River could be made navigable for about eight months in the year.

Assistant Davis estimates the amount of business for the calendar year 1886, from such information as he could pick up, at 2,000 bales of cotton, 22,000 pine logs, and 300,000 feet, B. M., sawed lumber. Return freights, planters' supplies, and general merchandise amount to about $100,000 in value. If the stretch of Little River from Catahoula Lake to Black River, about 25 miles, be worked over for one season only, at a cost not to exceed $100 a mile for all expenses, or, say, the sum of $2,500 in a single appropriation, nothing further should be required.

The work should be done by hired labor, under charge of a man who has gained experience in improved methods, especially in the use of high explosives. The contract method is undesirable in every way; unsatisfactory to those engaged in navigation and to the officer in charge. It is more economical and advantageous to the United States to have the profits go into the work and the wages of the inspector applied to pay the overseer in charge.

The stream from its source to this short stretch is not worthy of improvement in any way, and I do not consider the stretch between Catahoula Lake and Black River worthy of improvement or a public necessity to such a degree as to entitle it to a place among navigable waters of the United States for annual appropriation, but only as specifically recommended for one season's work. Anything further, such as cutting a leaning tree now and then or removing an occasional log from the way, should be done by the people who are directly benefited by the work.

No further examinations or surveys are necessary.

APPENDIX V.

IMPROVEMENT OF ARKANSAS RIVER, OF RIVERS IN THE STATE OF ARKANSAS, AND OF BLACK RIVER, IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Red River, above Fulton, Arkansas.
2. Little Red River, Arkansas.
3. Saline River, Arkansas.
4. Removing obstructions in Arkansas River, Arkansas.
5. Arkansas River, Arkansas.
6. Survey of Arkansas River, Arkansas, from Little Rock to its mouth.
7. Petit Jean River, Arkansas.
8. Fourche River, Arkansas.
9. White River, Arkansas.
10. Black River, Arkansas and Missouri.
11. Saint Francis River, Arkansas.
12. L'Anguille River, Arkansas.

EXAMINATIONS.

13. Little River, Arkansas.
14. Saline River, Arkansas.
15. Cache River, Arkansas.
16. Little River, Missouri, from Hornersville to its junction with the Saint Francis.
17. Saint Francis River, from Greenville Missouri, to the Arkansas State line.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1887.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1887, upon the works under my charge.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER, ABOVE FULTON, ARKANSAS.

The appropriation now available is the first ever made for work above Fulton, Ark., and was based upon a report made from this office November 12, 1884.

In that report $10,000 was asked for. The act approved August 5, 1886, appropriated $7,000, of which $4,000 was to be used to build a hand-propelled snag-boat.

The project contemplates improving high and medium stage navigation only, and proposes to accomplish this by operating a hand-propelled snag-boat (new model), with a powerful steam capstan, to remove snags and drift, the boat being of light draught so as to operate between low and middle stages of water.

During the fiscal year ending June 30, 1887, $3,154.46 were expended in the construction of the snag-boat *Harry Breck.*

This boat was built at a time when there was no work or very little in the State for ship carpenters, and when also boat lumber could be had very cheap.

A conscientious and efficient foreman of the old force was placed in charge, and the result is a boat that for the same money is seldom excelled. She has a very staunch hull, strengthened by three relieving arches, and is similar to the *A. B. Johnson*, that has done such effective work upon the Saint Francis, with a few improvements suggested by experience had with that boat.

She will draw about 15 inches of water when loaded and should be able to lift snags weighing 75 tons.

Experience upon rivers like this shows that only the snags in the low-water channel give trouble, and that these only should be removed.

It is a positive waste of public money to operate a snag-boat at any other stage, nor should a snag-boat drawing over 24 inches of water ever be sent into the work, as it can not generally get at the snags that require removal.

The continued low-water season in this river begins in August and continues until December. Acting upon the above experience, the new boat has been properly cared for since its completion, and will be put into the work when the proper stage of water arrives, say about the 1st of August, 1887. At that time work will have been suspended upon so many appropriations that a trained force will be available and the work can be carried on to the very best advantage.

The original estimate called for $3,000 more than was appropriated. This was a close and careful estimate, and if the work is to be properly completed it should be made available at once, while the plant is new.

It is therefore recommended that this sum be appropriated.

COMMERCE.

The amount of commerce, when the present appropriation was made, was 20,000 bales of cotton and 2,500 tons of merchandise.

The advantages to commerce, if the work is completed, will be very great; this stream, like many others, being the only outlet in many instances. The records of this office show that the country is being settled, and that the products are increasing annually.

As to benefits to community if completed, there will be a series of comparatively isolated communities that will receive great benefit from this work if completed. They are almost wholly dependent upon the river for transportation. The benefits likely to accrue would amount, if represented in money, to many times the total cost of improvement and preservation.

Three thousand dollars only is needed to complete the work, after the balance in hand has been expended. The river will require a little attention annually to keep it free of snags.

Money statement.

Amount appropriated by act approved August 5, 1886		$7,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,985.21	
July 1, 1887, outstanding liabilities	186.45	
		3,171.66
July 1, 1887, amount available		3,828.34
Amount (estimated) required for completion of existing project		3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT, IMPROVING RED RIVER, ABOVE FULTON, ARKANSAS.

Pay-roll, labor, etc	$1,856.81
Transportation	71.89
General supplies	1,090.30
Stationery	10.32
Traveling expenses	113.37
Fuel	11.00
Telegraph service	.77
	3,154.46
Reserved as per letter from Chief of Engineers, dated April 21, 1887	17.20
Total	3,171.66

V 2.

IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

The only improvements ever attempted upon this river were made in the year ending June 30, 1872, under the act approved March 3, 1871.

Prior to this work many overhanging trees and a large number of snags interfered with navigation in the lower reaches, and many bowlders obstructed flat-boat and raft navigation in the reach above the present town of Judsonia.

The appropriation referred to above was for the White, Black, and Little Red rivers, and amounted to $10,000 for the three, upon estimates amounting to $259,033, of which $38,065 was for the Little Red River. That but little work could be done is apparent from Colonel Reynolds's report for 1872, in which he states:

> Unless other and better facilities are provided, it will be of little use to attempt to remove the obstructions in such streams as these.

Most of the overhanging trees and snags were removed as high as Judsonia. A bad shoal 3 miles below Judsonia and the bowlders remained untouched to the end of June, 1886.

The act approved August 5, 1886, appropriated $3,000. The amount estimated as actually necessary was $8,400; $400 for the bowlders, $8,000 for dredging through the shoals.

During the fiscal year ending June 30, 1887, $400 has been expended in the removal of the bowlders above Judsonia. The most favorable season for work was selected, when the water was low and the party able to find food and shelter in the neighborhood of the bowlders.

A foreman with a small party of trained men, including a blacksmith, was furnished with drills, explosives, and portable forge and other tools necessary for the work, and successfully removed all the bowlders that interfered with rafting.

The examination upon which the estimate of $400 was based was made at comparatively high water. As a consequence, it was supposed that only about 190 cubic yards of rock would require removal.* This was done.

Much credit is due to the foreman who had charge of the work for the economy practiced. No further funds are needed for this part of the improvement.

The balance, $2,600, was inadequate *to build* the dredge boat required for the balance of the work. Up to the close of the fiscal year ending June 30, 1887, I have been unable to devise any plan for removing the shoal 3 miles below Judsonia, except by dredging. Of course cofferdams might be used and the money expended as far as it would go; but if the cut was not made the entire length of the shoal, navigation would not be benefited.

If it were possible to seize upon the exact moment of extreme low-water it might be possible to find men who would hold plows and scrapers in 2 feet of water, and thus the entire shoal be deepened about 1 foot.

This would only be about a third of the work required, and before resorting to these make shifts it was thought best to wait the further action of Congress. Five thousand four hundred dollars in addition to the balance on hand is the amount required to complete the project as per the original estimate. It is recommended that this sum be appropriated. Compared with benefits to be conferred upon the commercial interests, this amount is very small.

This stream is located in a very prosperous section of the State. The present commerce amounts to upwards of 13,500 bales of cotton and 4,700 tons of imported merchandise.

A great deal of fruit is being raised and the amount is increasing rapidly each year. The returns will be immediate.

COMMERCE.

Amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1871, page 362:

> The fact stated, that the commerce of this stream is sufficient to induce the comparatively large boats running on White River to navigate it whenever it is practicable, and when this is not the case that a small steamer is kept to ply between West Point and the mouth of the river, shows the importance of the interests involved.

As to prospective advantages to commerce if completed, if the shoals known as Bess Shoals were removed, so that a boat could reach Judsonia at all stages of the river, from 1,000 to 1,500 bales of cotton and

---

[*] It was found necessary to remove 323 cubic yards.

about 400 tons of general merchandise would be shipped by river at once.

A packet drawing 3½ feet of water now makes regular trips the year round to a point just below these shoals.

The country round about Judsonia has been visited in person, and I find its resources have only begun to be developed. I should say that the present commerce would double itself in five years.

As to benefits to community if completed, it is hard to estimate the benefits that cheap transportation would give to a community that has known only a railroad outlet, and only one at that.

No one will question but what they will be very great, how great can be told only by recalling what such transportation has done for other fertile sections; but it may be safely said that the benefits will be so great that the outlay will sink into utter insignificance.

Money statement.

Amount appropriated by act approved August 5, 1886	$3,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	412.90
July 1, 1887, amount available	2,587.10
Amount (estimated) required for completion of existing project	5,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	7,987.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT, IMPROVING LITTLE RED RIVER, ARKANSAS.

Pay-roll, labor etc	$202.00
General supplies	88.62
Subsistence supplies	35.00
Transportation	17.90
Traveling expenses	47.84
Stationery	5.78
Telegraph service	1.11
Fuel	1.75
	400.00
Reserved as per letter from Chief of Engineers, April 21, 1887	12.90
	412.90

V 3.

IMPROVEMENT OF SALINE RIVER, ARKANSAS.

Before improvement this river was obstructed by snags, logs, drift-piles, and overhanging trees and by shoals.

The original plan for improvement contemplated the rendering of its channel navigable as high as practicable or as commerce demanded by the removal of these obstructions, and then further improvement of the shoals if the commerce warranted.

There was expended upon this river up to June 30, 1886, $21,356.26. This has practically cleared the river so far as the navigation demands.

During the fiscal year ending June 30, 1887, $168.24 has been expended in the care of the property and the records.

Until the requirements of commerce are greater than they are now, it is not recommended that any further appropriations be made. From $5,000 to $6,000 per year would keep this river in a fair navigable condition during medium stages of water for 250 miles from its mouth, that is, up to Big Island, should it be required.

COMMERCE.

The amount of commerce when work of improvement began was as follows:

Cotton, about 20,000 bales, valued at	$800,000
Staves, timber, etc., estimated at	10,000
Hides, about 4,000 pounds, sundries, etc	2,000
Tobacco, about 15,000 pounds, valued at	2,000
Value of down freight	814,000
Return stores, supplies, estimated	500,000
Total	1,314,000

The effect upon rates of insurance and freight are not known.

The effect upon competing routes of transportation is not known.

As to prospective advantages to commerce if completed, the improvements have now been carried beyond the present demands of commerce.

As to benefits to community if completed, this river drains a very fertile country and can be made a very fine commercial highway during eight or nine months of the year, when the country is sufficiently well settled to demand it. At present steamboats seem to have abandoned the river. It was put in very good order in 1884 and 1885, and yet during that time only one steamboat appeared upon it, and that made but one trip.

Improvements now would appear to be premature, though the day hastens when they will be of great benefit.

Money statement.

July 1, 1886, amount available		$168.24
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$140.00	
July 1, 1887, outstanding liabilities	28.24	
		168.24

EXPENSE ACCOUNT, IMPROVING SALINE RIVER, ARKANSAS.

Pay-roll, labor, etc	$115.00
Office rent	30.00
Transportation	23.24
	168.24

V 4.

REMOVING OBSTRUCTIONS IN ARKANSAS, RIVER, ARKANSAS.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream; but from the delta-like character of its lower portion, and the tendencies now manifest in its upper reaches, it may be inferred, on very substantial grounds, that shifting sand-bars, numerous drift-piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees constituted those of the upper reaches. The numerous so called steam-boat graveyards now pointed out by old pilots support this idea.

Such annual reports of the Chief of Engineers as I have, dating from 1868, together with House Ex. Doc. No. 64, Forty-eighth Congress, first session, indicate that except at a few places, such as Pine Bluff, Ark., and Fort Smith, the general plan of improvement has consisted in snagging operations, which includes cutting overhanging trees, and in building wing-dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river.

For the exceptions noted, attention is respectfully invited to reports upon those special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections.

The grand total of all these appropriations up to June 30, 1886, amounts $440,251.87. Of this there had been expended to June 30, 1885, $346,535.46, exclusive of certain sums, aggregating over $100,000, that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Ark., 3 miles above Little Rock, Ark., in the year 1870. From the nature of the case the balance of the work has been each year a repetition of that of preceding years.

One iron-hulled snag-boat and one light-draught wooden snag-boat, with all the appliances necessary for snagging operations, were the visible signs of the balance, while the gratitude of those interested in the navigation of the river, for a navigation rendered yearly less and less dangerous by the operations of these two boats, is the only evidence existing and the only evidence to be expected of work that must be done in a stream like this, until by some system of permanent improvement caving banks no longer exist and the annual quota of snags is no longer furnished.

The most economical management of snag-boats requires not less than $35,000 annually to give absolutely indispensable aid to navigation; a navigation in which a vast amount of commerce is vitally interested.

About $7,000 was available in the year ending June 30, 1886, and $19,875 was appropriated in August, 1886.

In two years, then, to do $70,000 worth of work, there has been but about $27,000 of money.

Despite the most rigid economy and the practice of allowing the boats to work under the most favorable conditions, by which a great number of obstructions were removed, the snags have gained ground until one of the snag-boats even was sunk by a dangerous snag.

Being a staunch boat, it was raised and repaired. About the same time a boat of commerce was totally wrecked by a similar accident.

The appropriation made by act approved August 5, 1886, was expended between Fort Gibson and the mouth, where most required, the design being to give a good daylight channel, at first, and then widen it for the night running.

The funds were exhausted before a *day* channel could be opened. A short reach between Little Rock and Pine Bluff, and the entire reach between Fort Gibson and Fort Smith, with a few miles below Fort Smith, having to be left.

But for the sinking of one of the snag-boats, the reach last referred to would have had two or three weeks' work, which would have been very grateful to the river men.

The snag-boat *C. B. Reese* removed 1,134 large and dangerous snags, aggregating over 12,000 tons in weight, and 183 lighter ones, cutting also 143 trees upon caving banks.

The powerful light-draught boat *Henry Sheldon* was transferred to this river to work its upper reaches, and removed 68 bad snags before being disabled by one of them.

The *Wichita*, designed for these reaches, is no longer serviceable on account of her decayed wooden hull. As the *Henry Sheldon* is required ordinarily upon the White and Black rivers, it is very desirable that the next appropriation should be large enough to build a new hull for this boat, its machinery and upper works being in prime condition. By modeling her after the *Henry Sheldon* she will be able to cope with the heavy snags in the upper river that have been too heavy for her so far.

This will require no new machinery except capstans.

Under the proper heading will be found recommendations in regard to the permanent improvement of the river. When such improvement is made, snagging, except upon a very small scale, will be no longer required. That prompt attention to the permanent improvement would save the present heavy outlays for snagging, goes without saying, but until it is attended to, commercial interests will suffer greatly, unless money is available to keep the channel free from snags.

In three years there has been a most remarkable interest developed in industries of all kinds, and this State is like a young State in many respects.

The people are waking up, but there having been no systematic effort made to gather statistics, those submitted here will fall much below what actually could be given were there any records.

For statistics, as well as for other data, the report under head "Improving Arkansas River, Arkansas," should be read in this connection.

After what precedes, it will be seen that a larger appropriation than usual will be now required, as the work is so far behind. Ten thousand dollars will be required to build a new hull for the *Wichita* and to transfer the upper works, and $60,000 should be at once made available for snagging. It is therefore recommended that $70,000 be appropriated for improvement under this head.

In my last annual report it was recommended that $1,500 be appropriated to complete the survey from Wichita, Kans., to Little Rock, Ark.; $1,125 was appropriated. Of this, $570.83 has been expended in reducing and tracing the unwieldy field maps of the reach from Fort Gibson to Little Rock; $373.50 will be expended in photolithographing the same, and this will leave but $180.67 for the reach from Fort Gibson to Wichita. It will require fully $555.67 to complete, and it is recommended that the $375 be appropriated, to make the total $1,500.

This will place these maps in convenient and permanent form for preservation, and as so much trouble and expense have already been incurred it would seem a great pity to leave the matter where it now stands.

COMMERCE.

As stated in this report, this work was begun in 1833, and there are no records available in this office to show what commerce, if any, passed over this river. In 1852 a gentleman in Little Rock lost five out of six of the steam-boats owned and run by him in one season—due to snags. Navigation must have been very uncertain in 1833, and commerce light.

It is estimated that insurance and freight rates have been reduced one-third by the improvement already effected. As to effect upon rates of competing routes of transportation, there are many points where there is no competition. Where there are, cotton is carried at 25 to 50 cents per bale cheaper by water than by rail, and other merchandise accordingly. This must keep railroad rates down.

As to prospective advantages to commerce if completed, observations show that whenever the snag-boats by thorough work get the channel reasonably well cleared the boats run night and day, eagerly taking advantage of the brief interval before appropriations fail and the annual crop of snags can not therefore be removed. For further details, see the report for improving Arkansas River, Arkansas.

As to benefits to community, if completed, nothing better can be furnished under this head than a few extracts from a letter from the Little Rock Board of Trade, of date July 27, 1886, as follows, viz:

> The region to be benefited by the improvements embraces the richest lands west of the Mississippi River, the center of cotton production per acre in natural soils in the United States and probably in the world.
>
> Twenty of the most populous and productive counties in the State of Arkansas are directly interested in this measure of river improvements. In 1880 these counties had a population of 256,664, and produced 212,373 bales of cotton and 7,000,000 bushels of grain, corn, oats, rye, wheat, etc.
>
> The State increased in population during the last decade 65 per cent.; in area of tillable lands, 84.5 per cent., and doubled her crop of cotton.
>
> The commercial growth and prosperity of Fort Smith, Little Rock, and Pine Bluff, the three largest cities in the valley of the Arkansas, demonstrates that to-day over 300,000 industrious and deserving citizens are closely concerned in the improvement of the Arkansas River.
>
> As to the lumber and forest products, the coal and other articles which should have cheap transportation, a channel such as is proposed would benefit a large and growing class of industries and a prospective commerce of very large proportions.

For further details, see report for improving Arkansas River, Arkansas.

For plans and estimates for the reach from Wichita, Kans., to Fort Gibson, Ind. T., see Ex. Doc. No. 90, Forty-ninth Congress, first session.

Money statement.

July 1, 1886, amount available	$1,310.10	
Received from sale of fuel to officer	6.00	
Amount appropriated by act approved August 5, 1886	19,875.00	
		$21,191.10
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	18,534.65	
July 1, 1887, outstanding liabilities	229.50	
		18,764.15
July 1, 1887. amount available		2,426.95
Amount (estimated) required for completion of existing project, annually, until permanent improvements are effectively begun		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		70,375.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT, REMOVING OBSTRUCTIONS, ARKANSAS RIVER, ARKANSAS AND KANSAS.

Pay-roll, labor, etc	$13,378.67
General supplies	1,549.48
Subsistence supplies	1,820.96

Fuel	$1,680.92
Traveling expenses	68.35
Stationery	14.85
Medicine	13.35
Transportation	220.40
Telegraph service	19.64
Rent of office	48.75
	18,751.25
Reserved, as per letter from Chief of Engineers dated April 21, 1887	12.90
	18,764.15

V 5.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

By act approved August 5, 1886, $75,000 was appropriated under this head, its distribution being indicated in the following words and figures:

> Improving the Akansas River, Arkansas, Continuing improvement, according to the plan and recommendations in Appendix V 13, Ex. Doc. 1, Forty-ninth Congress, of which there are to be expended $8,000 at Pine Bluff, $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof under these sums respectively as may be necessary at these points.

The approved project for the expenditure of this sum may be summarized as follows:

At Pine Bluff the $8,000 is to be used in extending and repairing the dikes, a portion of it to be held as a contingent to watch the action of the river, the idea being to cause the river to become less and less dangerous to the town front.

At Fort Smith the $13,000 to be expended in erecting a permeable dike a little above the town and upon the opposite side of the river, so as to contract the channel and prevent it from leaving the city wharves.

At Dardanelle the $10,000 is to be expended in erecting a permeable dike above and opposite the town in such position as to remove the sandbar now in front of the wharves.

From Little Rock to the mouth the balance, and so much as may not be required at the three places above specified, to be expended in the erection of permeable dikes at the worst places, looking towards the permanent improvement of the river, to give an all-year-round depth of water of at least 5 feet at extreme low water.

These dikes to serve as contraction works, but in no instance is violent contraction to be attempted.

All the dikes referred to in these projects to be about 12 feet in height above mean low water.

The works to be carried on by hired labor and the purchase of material in open market, as this is believed to be most economical and advantageous to the Government.

Before operations were begun at Fort Smith, the old jetty at that place, built in 1877 and 1878, had so far disappeared as to render no service, and the river was about to throw a bar along the wharves of the town.

At Dardanelle a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage.

At Pine Bluff the condition before improvement may be found by referring to the report "Improving the Arkansas River, Arkansas, Pine Bluff," and were of so grave a nature that a re-enumeration here would occupy too much space.

From Little Rock to the mouth of the river the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water.

In all cases of this kind the crossings occur at points at which, while the river is falling from a 10-foot stage to extreme low water, its water is so widely spread that it develops no channel at any point.

Three years of careful study of the river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing, and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps, just sufficient to give defining character to the current, will convert a bad crossing into a good one.

During the fiscal year ending June 30, 1887, $4,410.15 were expended at Pine Bluff in care of property, repairs to plant, and extension of Dike No. 1.

The steady fill that occurred along the town front during the year ending June 30, 1886, being produced so largely by Dike No. 1 that it appeared that to continue the successful protection of the town and remove the dangerous limits of the action of the water farther from the same, it was only necessary to extend this dike. No heavy rise has occurred since it was completed. A 12-foot rise, however, has shown that the desired results will be secured.

Upwards of 100 feet of the opposite bank caved in, and the point of impact of the forces of the current was moved from the end of Dike No. 2 to that of Dike No. 3, and extensive filling took place along the entire front, except the lower blocks, and it is fast gaining upon them.

The old works are all in excellent condition. Back of Dike No. 2, where the worst action of the river occurred in 1883 and 1884, there is flourishing three-fourths of an acre of young willows and cottonwood, from 3 to 5 feet high, over a place where there was from 35 to 40 feet of water at extreme low water.

A judicious watch is all that is now needed to preserve the town and the navigation of this reach. The town has taken on a new life, street railways, new water-works, the latter located where the greatest danger lay in 1882 and 1883, and a fine hotel, one of the finest in the State, right back of the point where in 1883 and 1884 120 feet represented the inroad of the river in one season, are a few of the many things to show what has been effected by the works.

As the Arkansas River may change its regimen above the city and bear down upon new curves, and so take the works at a disadvantage, a contingent fund of $8,000 should be made available for the fiscal year ending June 30, 1889. If it is not all required at this point, and the chances are that only a small part will be so required, it can be used elsewhere.

All the plant formerly used here is now doing splendid service upon the general improvement from Little Rock to the mouth. The repair of this plant and some other expenses in a small way that pertained to the general heading referred to have been paid out of this allotment in accordance with the terms of the act.

At Fort Smith $12,662.49 were expended in the erection of a permeable dike 1,300 feet in length, extending from a point upon the bank of the Arkansas River opposite the town, and from one-half to three-fourths of a mile above the same.

This dike consists of foot mat of brush and poles woven continuously from the shore to 50 feet beyond the end of the dike, and 100 feet wide, and weighted with stone from the old dike so far as they would go and with boxes filled with sand for the balance.

Through the axis of this mat a row of piles is driven, the piles 8 feet apart, and the row is wattled with brush to a height from 12 to 16 feet above low water, and strengthened by horizontal stringers connecting the piles in the row, just above the wattling, and by diagonal braces extending from near the top of each pile to a horizontal stringer laid at the foot of another row of piles driven parallel to the first row, and at a distance of about 10 feet from it.

No rise of any moment occurred during the erection of this dike, or up to the end of the fiscal year, so no report can be made as to the effects produced by it. It is not believed that any more funds will be required at this point. The surplus material and the plant has all been transferred to Little Rock, for use in the same manner as outlined in the case of the Pine Bluff plant.

The small balance of $337.51 has not yet been applied elsewhere, in accord with the provisions of the act, in order that time might be had to see whether it should be required to repair some minor breach in the dike. When it becomes evident that it is not so required, it will be utilized below Little Rock as directed.

At Dardanelle $6,189.17 were expended in the erection of a permeable dike 300 feet long, in all respects similar to the one erected at Fort Smith, except that material being cheaper, a horizontal stringer was added to the lower row of piles, and horizontal as well as diagonal braces used, giving a stronger dike, as it is subjected to the action of greater forces than at Fort Smith. As at Fort Smith no rise has occurred and no results can be reported.

This does not complete the work at this point.

The problem of transferring the river to the wharves without caving the banks next the town requires care in its solution, and as no expense accrues by virtue of the suspension, it seemed best to erect a length of dike clearly too short, and note its effects carefully, and thus be able to tell practically how much additional work will be required.

With the success had so far, the necessary work should be completed and a small balance left for use elsewhere, as provided.

From Little Rock to the mouth $6,655.15 were expended in beginning the work according to the approved plans. The plant was collected and put in order for work, material purchased, and the mattress for the first dike nearly completed.

Active operations were not begun until June 6, 1887, due to two causes. From September 1, 1886, to February 15, 1887, there was no time at which the Board of Engineers could view the river owing to continued low water.

After the project was approved, the river was too high for effective work until about the time specified. This delay will be an advantage in one way, since as the appropriations for other works in this district are largely exhausted, experienced men can be secured for this work. Economical work can therefore be done, and even this small sum be made to tell in favor of navigation, for at least the light draught boats.

There are some three or four bad crossings between Little Rock and Pine Bluff, and about as many between Pine Bluff and the mouth of the river that interfere with such boats.

The improvement of these places for these boats being directly in the line of the improvement as set forth in the original plan gives a good opportunity to test the plan if there is any doubt about it, and it is believed that with ordinary success by February 14, 1888, all these places will have received attention.

The continued success of the works at Pine Bluff, which involve the principles upon which the new works are based, warrants the belief that the new works will succeed as well.

So far as the plans have been elaborated to that extent that they have fallen under the eyes of men long familiar with the operations of the Arkansas River, they meet the unanimous approval of these practical men. Theory and practice thus harmonizing, good results must follow, especially where, as in this case, the plans were wholly evolved before the men who are now so confident of their success in a practical way knew of their general character.

It may be well to state that at all these points the river spreads over so much territory while falling from a 10-foot to a 3-foot stage, that it loses defining power at any given point.

The permeable low dikes will simply act in a mild way to give this defining power at, say, from a 6-foot stage down, acting as stumps, logs, and trees often do, to produce a good channel, where but for these simple obstacles there would be none at extreme low water.

As $250,000 was named as the amount that could be profitably expended and but $44,000, plus the surplus from Pine Bluff, Fort Smith, and Dardanelle, was appropriated, it is evident that only a beginning can be made.

By using plant already in existence, this can be made available as indicated. To enter upon the project properly the first appropriation should be at least $250,000, in order to purchase the best plant.

To complete the project as set forth in Appendix V 13, Executive Document 1, Forty-ninth Congress, $2,494,544 will be required, of which $250,000 can be profitably expended during the fiscal year ending June 30, 1889.

I would respectfully invite attention to the wonderful development of this State, and the natural tendency of all this to make Little Rock a great commercial center.

All the statistics connected with all my reports bear upon this more or less. As the reach of river under consideration has Little Rock at its head, the great importance of these works becomes more apparent.

A careful study of statistics for three years convinces me that the State of Arkansas will ere long rise many files in the rank of the States, and public improvements will return manifold their cost in material benefit to the entire State.

COMMERCE.

It is difficult to ascertain the amount of commerce, when work of improvement began, for the entire reach in question, but some idea may be formed of it when it is remembered that in my last annual report the river trade of Little Rock alone is set down at $1,635,000 by careful computation, exclusive of its greatest staples, cotton and cotton seed.

Some idea of the commerce of Little Rock alone can be had from the following condensed statements, taken from the published report of the Little Rock Board of Trade for the year 1886:

Total annual sales of merchandise of all kinds		$13,790,860
Total annual shipments of apples, onions, etc	pounds	5,694,607
Total annual shipments of flour and meal	do	12,472,273

Total annual shipments of grain and bran	pounds..	$33,147,539
Total annual shipments of packing-house products	do....	8,467,933
Total annual shipments of live stock	do....	2,972,205
Total annual shipments of cotton	bales..	63,050
Annual river trade		1,600,000

See also Annual Report of Chief of Engineers for 1886, pages 1390, 1391.

As work was only begun in June, and is not fully under way, it is too soon for any results in the way of reduced rates of insurance and freight. Effect upon rates of competing routes upon transportation can not be known for the same reason.

To give the advantages to commerce, if completed fully, would be to enter upon the commerce of a great State, and would require an amount of time for compilation and record that would be entirely out of the question. It is forecasting the future of the State's metropolis and railroad center. All that prevents two-thirds of the freight now sent and received at Little Rock from being handled by the river, is the fact that there are months of great uncertainty and the time lost by the boats exhausts the profits.

Probably no data better than that given in the board of trade circular appended is available, yet I am satisfied that this only represents about half that could be presented were there means of getting at the shipments along the river.

As to benefits to community if completed, the rapid increase in prosperity of this State, during the two years spent at this office, reminds me more of the frontier growth of the West than of the growth of a State of the age of this one.

The best statistics that I have are all found in the board of trade circular, but it is my duty to add that the records of the past are no criterion, from the fact that this State is coming forward with giant strides.

It would be redundancy to reproduce in this report the printed matter found in the circular. It is my belief that this circular will prove ample to convince any one of the great benefits to be conferred, yet a just conception can only be formed by looking at some great fertile river valley in the northern or eastern States as they were years ago, and as they are now since settled up, with its river improved.

What benefits have accrued to that community will surely accrue to this, with this addition, that the mineral resources of this valley are to be added. Its coal products alone and its wealth of timber will place it well to the fore.

When the vast acreage of the Indian Territory is brought under cultivation, its products must go this way.

That already well known and exceedingly fertile State of Kansas will find Fort Smith or Little Rock its nearest water outlet, eventually.

It will be seen how difficult it is to handle this question briefly, if it is borne in mind that with deep water to New Orleans from the Gulf, the Mississippi improved, and the Arkansas River navigable to Little Rock by boats drawing 5 feet of water, we have the conditions likely to exist when the improvement is completed.

I have, therefore, only attempted to outline this matter, and trust that when this portion of the report is read, a map of the territory covered may be had in mind, as this will probably be of itself the strongest proof that the benefits likely to accrue can but be too vast to be summarized in a report like this.

Money statement.

Received from sale of fuel to officer		$13.50
Amount appropriated by act approved August 5, 1886		75,000.00
		75,013.50
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$26,662.40	
July 1, 1887, outstanding liabilities	3,482.46	
		30,144.86
July 1, 1887, amount available		44,868.64
Amount (estimated) required for completion of existing project		2,494,544.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNT, IMPROVING ARKANSAS RIVER, ARKANSAS.

Pay-roll, labor, etc	$13,029.61
General supplies	12,993.53
Transportation	1,618.95
Stationery	26.58
Telegraph service	31.56
Traveling expenses	1,174.41
Fuel	149.34
Rent of office and land	376.75
Subsistence supplies	516.23
	29,916.96
Reserved as per letter from Chief of Engineers, April 21, 1887	227.90
	30,144.86

IMPROVEMENT OF ARKANSAS RIVER AT PINE BLUFF, ARKANSAS.

The reach of river that lies in the vicinity of Pine Bluff, Ark., was in a very bad condition prior to any attempts at improvement.

At one point a cut-off was threatened, which would change the slope of the river from three-fourths of a foot per mile to 4 feet per mile.

At another point a bad bar interfered with navigation at low water, and in the sharp bend in front of the town of Pine Bluff the river was eroding the banks with a rapidity that threatened the town.

The original project proposed—

(1) To protect the river bank in front of the town from further erosion.

(2) To rectify the course of the river in the bend above town in order to remove a bar now existing there, and also by diminishing the curvature of the bend to lessen the tendency to excessive scour in front of Pine Bluff, and

(3) To prevent the formation of a cut-off then threatened across the peninsula opposite Pine Bluff.

The whole improvement to extend over 13 miles of river.

Sixty-seven thousand two hundred and eighty-seven dollars and fourteen cents was expended upon this project up to July 1, 1884, but owing to having been expended in small sums, by which the works were generally left in an incomplete state, they were all carried out, with the exception of one wire-curtain dike, without producing the effects desired.

After the passage of the act approved July 5, 1884, giving $55,000 to this locality, a new project was prepared. This provided for a dike upon the lower end of the bar above the town to accelerate the prolongation of that bar, and also to deflect the main body of the water so as to cause the river to impinge upon the town with less force and from a different quarter.

It was expected that erosion would take place opposite the dike. Other dikes were to be located along the town front to check the velocity of current and cause a deposition of the eroded material hereinbefore mentioned; a contingent fund to be reserved to watch effects and correct any unforeseen tendencies of the river.

Upon this new project there had been expended to June 30, 1886, $53,034.67, producing the desired effects as set forth in detail in former reports.

During the fiscal year ending June 30, 1887, $2,472.83 were expended in extending Dike No. 1 and in the care of the property and records. Observations showed that the extension of Dike No. 1 was the most effective means of affording additional protection to the town-front, as it removed the point of impact of the main force of the current further down stream, and by forcing the river to cave the opposite bank and cut out the bar, gave an increased amount of material for deposit along the town-front.

The effective action of the entire works, as set forth in my annual reports for 1885 and 1886 (Annual Reports Chief of Engineers, 1885, page 1564, and of 1886, page 1375), has continued, enhanced by additional works.

A bar is rapidly forming along the entire town-front, except a few of the lower blocks.

Every rise moves the river further away from the upper part of the town and adds large deposits below and around the permeable spur-dikes along the town front.

The fill in this concave bend in numerous places amounts to from 30 to 40 feet. The most marked fill in what was the worst place exceeds 70 feet. The river shows a slight tendency to reach the banks between Dikes Nos. 2 and 3, due to its point of impact having moved from between 1 and 2 to the locality specified. An extension of either No. 1 or 2 will speedily stop this, as this accords with the plan. The river, however, is taking a gentler curve, and it is desirable to avoid the expense of giving any extra protection here if possible.

A contingent fund is all-important at this point. Another contingent of about $8,000 should be made available for the fiscal year ending June 30, 1889, to simply hold and further the results already accomplished.

It should be borne in mind that a very small outlay of money is now accomplishing results that several hundred thousand would not do if applied to placing artificial walls in front of the town.

The river is doing the work of protecting the banks, aided by an insignificant outlay of money. It is liable to change its methods of work more or less, and a small sum is required to alter the works and drop in a few new ones to meet these changes. It may now be said that with such a contingent the salvation of the town is assured.

Much that is interesting in a general way relative to the prolongation of bars and the protection of caving banks might be noted here.

Suffice to say that the Arkansas River, being comparatively free from ice in its lower reaches, and carrying much sediment at times, it is possible, by the erection of very slight and comparatively inexpensive works, to control the formation of bars and to protect caving banks in such a manner as to give great aid to navigation and protection to the banks.

In recommending that $8,000 be appropriated, I will add, as last year, that this seems a very slight amount in view of the vast interests at stake; but it is perfectly adequate in the hands of any engineer who understands the nature of large alluvial streams. It must, however, be steadily provided, or hundreds of thousands will represent the money needed to repair damages.

The universal verdict at Pine Bluff is now that the Arkansas River is *now* under control. The annual contingent of $8,000 can not be regarded as needed for experiment, but simply to erect structures that time has shown are capable of absolutely controlling the river in this its very worst reach, when all interests are considered. In this connection my report for 1885 should be carefully read.

The importance of the interests at stake in this reach would warrant an epitome of the principal statements embodied in that report. As these are all, however, now a matter of printed record, such an epitome would be surperfluous. It should be distinctly remembered, however, that no serious study should be made of this reach without a careful examination of the report referred to, as the recommendations contained in this report are based almost entirely upon facts and figures found in that one.

Money statement.

July 1, 1886, amount available	$2,465.33
Received from sale of fuel to officer	7.50
	2,472.83
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,472.83
Amount (estimated) required for completion of existing project, annually, until river is permanently improved above	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT, IMPROVING ARKANSAS RIVER, PINE BLUFF.

Pay-roll, labor, etc	$1,777.84
Subsistence supplies	9.00
General supplies	448.48
Traveling expenses	18.47
Fuel	165.95
Telegraph service	1.31
Transportation	9.40
Stationery	9.05
Rent of office	33.33
	2,472.83

PROJECT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., September 24, 1886.

SIR: In accordance with the requirements of a letter from the office of the Chief of Engineers, dated August 12, 1886, I have the honor to submit the following project for the prosecution of the works of improvement under the heading "Improving the Arkansas River, Arkansas: Continuing improvement, seventy-five thousand dollars, according to the plan and recommendations in Appendix V 13, Executive Document one, Forty-ninth Congress; of which there are to be expended eight thousand dollars at Pine Bluff, thirteen thousand dollars at Fort Smith, and ten thousand dollars at Dardanell, or so much thereof under those sums, respectively, as may be necessary at those points," viz:

For the sake of perspicuity the project should be divided into four heads, from the wording of the appropriation, viz:

I. The works of improvement at Pine Bluff, Arkansas.

II. The works of improvement at Fort Smith, Arkansas.

III. The works of improvement at Dardanelle, Arkansas.

IV. The works of permanent improvement of the Arkansas River, according to the plans and recommendations in Appendix V 13, Ex. Doc. 1, Forty-ninth Congress.

I. THE WORKS OF IMPROVEMENT AT PINE BLUFF, ARKANSAS.

A triple problem presents itself at this point. In a 13-mile reach of river a dangerous cut-off is threatened, navigation has been difficult on account of bad shoals, and prior to the expenditure of the $55,000 appropriated by act approved July 5, 1884, the river threatened to sweep the town of Pine Bluff out of existence.

The most imminent danger lay in the latter condition in July, 1884, and the plans and project upon which the appropriation just referred to was expended looked to saving the town, and consisted in the use of both solid and hurdle dikes to deflect the current from the bank, to cut out the bar above the town, and throw a bar into the bend along the town front.

As stated in the annual report, upon which the amount now in question was appropriated, these works have been very successful.

At the present writing there are very heavy deposits taking place along the greater part of the town front. This appropriation being based upon the estimate given in my annual report on page 1568, and again on page 1578, Appendix to the Annual Report of the Chief of Engineers for the year 1885, it constitutes the contingent fund to be used in caring for this entire reach in a threefold manner.

In view of the foregoing I have the honor to recommend that the $8,000, or "so much under that sum as may be necessary," be expended as follows, viz:

1. The town front shall be given additional protection by extending the dikes already constructed and building one short hurdle dike if necessary.

2. The tendency to a cut-off shall be watched, and, if necessary, short dikes constructed to prevent its occurring.

3. The bars in the vicinity of the Rob Roy Bridge shall be observed, and correcting dikes erected to prevent the obstruction of navigation at that point.

The present needs, as per a recent visit, are confined to the recommendations set forth in No. 1.

A heavy rise, however, may require attention to the details set forth in 2 and 3.

II. THE WORKS OF IMPROVEMENT AT FORT SMITH, ARKANSAS.

The sum appropriated by act approved August 5, 1886, is the exact amount recommended by myself in the second indorsement upon a letter from the Hon. J. H. Rogers to the Hon. C. R. Breckinridge, which was referred to the office of the Chief of Engineers by the honorable Secretary of War, and thence to this office, in an indorsement dated office of Chief of Engineers, U. S. Army, Washington, D. C., July 15, 1885. While, therefore, this is associated with moneys that were appropriated on estimates contained in Appendix V 13, Ex. Doc. 1, Forty-ninth Congress. It is presumed that it was made to meet the recommendations contained in said indorsement. This fixes the plan and project at once.

It should be noted before proceeding to recommendations that in 1877 and 1878 a brush and stone dike was erected with a view to contracting the water-way. This dike was 1,100 feet long at right angles to the general direction of the river with a return of 600 feet parallel to the same general direction. The records of this office show that this did good work, but it sank of its own weight until it has dropped too low to be effective.

The indorsement referred to, upon which this appropriation is based, recommended the placing a hurdle dike upon the site of the 1,100 feet of old dike, or as near as may be, and for 200 feet of the return.

I have, therefore, the honor to recommend that the $13,000, "or so much under that sum as may be necessary," be expended in erecting a hurdle dike as indicated above, and according to the details shown in the accompanying tracing, modified to suit any special local conditions that may be found to exist, the piles that are used to be protected against scour by well-weighted foot-mats similar to those used so successfully at Pine Bluff, Ark., and weighted in a similar manner.

A careful examination of existing conditions will be made prior to erecting the works, and if a slight change in the location of the dike will give better results, such change will be made, providing always that no increase is made in the cost of construction.

III.—THE WORKS OF IMPROVEMENT AT DARDANELLE, ARKANSAS.

The sum appropriated by act approved August 5, 1886, is the exact amount recommended by myself in the indorsement referred to under the previous heading relative to the works at Fort Smith. The same course of reasoning under that head fixes also this plan and project. These works differ from those at Fort Smith in being entirely new, there having been, so far as any records show, no work ever done here, except the removal of snags.

The indorsement referred to, upon which this appropriation is based, recommended that a hurdle-dike be erected upon a bar above the town to contract the channel in keeping with the general plan for the permanent improvement of the river, and at the same time to meet the requirements of the local interests, thus permanently improving the bar and opening the harbor of Dardanelle to commerce.

With the foregoing in view, I have the honor to recommend that the $10,000, or "so much under that sum as may be necessary," be expended in the erection of a hurdle-dike, as indicated above, and according to the details shown in the accompanying tracing, modified to suit any special local conditions that may be found to exist.

The piles that are used to be protected against scour by well-weighted foot mats, similar to those used at Pine Bluff, Ark., and weighted in a similar manner. A careful examination of existing conditions will be made prior to erecting the works, and the dike located accordingly.

It is not possible to lay down on paper the exact locality at which the dike is to be placed, because the river is building to the bar upon which the dike is to be located. The design of the dike is to prolong this bar, deflect the current, and cut out the bar below. The greater the production of the bar the lower the dike can be placed, and the greater its effectiveness and, therefore, the less its cost.

In building it, it is proposed to pursue a tentative process, *i. e.*, erect a few hundred feet and watch the effect of a rise. This is necessary, inasmuch as too great length of dike might throw too strong a current upon the bar next to town and thus interfere with local interests.

These reasons might be further elaborated, but it is believed that it is well understood that upon alluvial streams of rapidly changing regimen the successful location of the works depends upon too many vicissitudes to render it possible to bring it under a right line pen and ruler.

IV.—THE WORKS OF PERMANENT IMPROVEMENT OF THE ARKANSAS RIVER ACCORDING TO THE PLANS AND RECOMMENDATIONS IN APPENDIX V 13, EXECUTIVE DOCUMENT 1, FORTY-NINTH CONGRESS.

Deducting from the $75,000 appropriated the sum of the amount already provided for and there remains $44,000.

Two hundred and fifty thousand dollars was the amount that could profitably be expended during the present fiscal year, according to the plans and recommendations referred to in Appendix V 13, Ex. Doc. 1, Forty-ninth Congress.

These plans provided for the permanent improvement of the Arkansas River, from Little Rock to its mouth, to be effected by the use of primary and secondary hurdle dikes, to contract the water-way, and give a channel 200 feet wide and at least 6 feet deep at extreme low water. These hurdle dikes to be in height 16 feet above mean low water, and to be in every respect similar to those in use at Twin Hollows and Horse Tail Bar, on the Mississippi River.

A moment's reflection shows that to start this work as an independent one, building plant in keeping with the magnitude of the work contemplated, which will ultimately require the expenditure of upwards of $2,500,000, a much larger sum than that appropriated would be required to purchase the plant. It therefore remains to provide some means of expending this, as far as it will go, in some judicious manner.

The plant used at Pine Bluff will be only required there for a short time, and is probably ample for the works that this sum will build, and will be best preserved in active service.

Pending further action of Congress, I therefore have the honor to recommend that $44,000, and so much of the other sums as may not be required under their respective heads, be expended in beginning the works of improvement according to the plans specified above, making use of the plant now at Pine Bluff, with such additions as may seem advantageous, keeping in view the entire scope of the works.

The transfer of this property will be made the subject of a separate communication.

The work shall be begun at Little Rock, Ark., and extended as far as the funds will admit.

If after opening the works the plant is found inadequate, the right is to be reserved of proceeding to build, or purchase, under proper authority, plant in keeping with the future requirements of the work, even though no funds will remain for actual river work.

It is practically certain that the Pine Bluff plant will meet every requirement for this small amount.

The accompanying sheets, Nos. 1 and 2, show in a general way the location of the works, It will be remembered, however, that in alluvial streams a survey at the time of erecting the works alone shows exactly where they should ultimately be located.

It is believed that the details of the primary and secondary hurdles used at the localities mentioned, on the Mississippi, are too well known to render it necessary to delay this project for drawings of them. These will be provided, however, if desired.

The violent floods in the Arkansas River renders another reservation necessary, viz: That, if in the prosecution of the works it appears that to carry them further will be to expose incomplete works (incomplete through lack of funds) to destruction, work will be suspended and the money held in the Treasury, or invested in plant, until the future action of Congress shall be known.

In all this work the piles used shall be protected by foot-mats as at Pine Bluff, where the works have been effective, *i. e.*, with well-woven foot-mats weighted with sand boxes.

It is further recommended that all the works under I, II, III, and IV, be prosecuted by hired labor and the purchase of material in open market.

This is believed to be most economical and advantageous to the Government, and for the following reasons, viz:

1. The execution of the work requires expert labor, of which I have a trained supply, which contractors would find it difficult to duplicate.

2. The Government now has some plant specially adapted to this work, and if the money is practically available in some instances, it can only be so by utilizing this plant.

3. It would be very difficult to draw plans and specifications so clearly for works so full of unexpected conditions that reliable contractors will feel safe in bidding upon them.

4. The works, in order to be successful, must be modeled after those known to be so in this river, and can but be so modeled by the assistants and foremen who have been in the employ of this office, and who are perfectly familiar with all the vicissitudes and dangers incident to the work, and who can be absolutely controlled in every detail by this office, as contractors could not be controlled. Further, the sudden rises and changes to which the river is subject renders it imperative that the officer in charge be able to suspend work or resume at any moment; conditions contractors find it difficult to provide for in a close bid.

I have still further to recommend, in event of the approval of this project, that authority be granted to hire so many civil engineers, not to exceed four, at a salary not to exceed $150 per month each, as may be necessary to properly carry on the works, provided that but one civil engineer shall be employed at either Pine Bluff, Dardanelle, or Fort Smith, and that not to exceed one shall be employed upon the other works, unless there be works so widely separated as to require an engineer for each locality.

Authority is also requested to hire such foremen, time-keepers, receivers of material, mechanics, steam-engineers, master pile-drivers, cooks, and laborers, at current rates, as may be necessary to properly prosecute the work, and where necessary to subsist the parties in the field. This latter will not be necessary at Pine Bluff or Fort Smith, but may be at Dardanelle and upon the works upon the permanent improvement.

The tracing accompanying this, marked Plate I, is filed to show the general arrangement and details of construction of the hurdle-dikes proposed at Pine Bluff, Fort Smith, and Dardanelle, but not of the primary and secondary hurdles for the works from Little Rock, Ark., down the river.

Plate II is designed to show the location of the old dike at Fort Smith, that the probable site of the new one as laid down in the project may be seen.

When this locality was examined about one year ago, it appeared that the works could be located higher up-stream to better advantage.

The photolithograph sheets 1 and 2 have already been referred to. They are intended for file, and to indicate the spirit of the works rather than to show the exact location, as this can only be ascertained by soundings and careful observations just prior to erecting the works. The proposed works are shown in red ink.

If desired, tracings of the full-sized sheets will be furnished, showing soundings and outlines of bars at extreme low water.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 27, 1886.

Respectfully submitted to the Secretary of War.

The river and harbor act approved August 5, 1886, provides for—

> Improving Arkansas River, Arkansas: Continuing improvement, $75,000, according to the plan and recommendations in Appendix V 13, Executive Document 1, Forty-ninth Congress, of which there are to be expended $8,000 at Pine Bluff, $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof under those sums, respectively, as may be necessary at those points.

Work at Fort Smith and Pine Bluff has already been carried on under previous appropriations and will be continued in accordance with the approved plans. No money has been expended at Dardanelle, and the appropriation for improvement at that point is based upon a report made upon a communication from the Hon. J. H. Rogers, M. C., to the Hon. H. C. Breckenridge, and referred by the latter to this office (papers herewith). The proposed application of the appropriation is recommended for approval. In regard "to the plan and recommendations in Appendix V 13, Ex. Doc. No. 1, Forty-ninth Congress" (copy herewith), for the carrying out of which the sum of $44,000 is made available, it may be said, in view of the magnitude of the work contemplated, involving for its execution the expenditure of upwards of $2,500,000, that before commencement it would seem advisable that the plan receive the consideration of a Board of Engineers, and with the approval of the War Department it will be referred accordingly.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
November 2, 1886.

Approved as recommended by the Chief of Engineers.

By order of the Acting Secretary of War.

SAM'L HODGKINS,
Acting Chief Clerk.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 10, 1886.

SIR: The project of September 24, 1886, herewith received at this office from Capt. H. S. Taber, Corps of Engineers, for the application of the appropriation of the river and harbor act of August 5, 1886, for improving Arkansas River, is referred to the Board of Engineers for Fortifications and for River and Harbor Improvements for consideration and report upon the general subject of the improvement of the navigation of Arkansas River, in view of the magnitude and great cost of the work contemplated in the plan and recommendations in Appendix V 13 of the Annual Report of the Chief of Engineers for 1885, in accordance with which the act requires the expenditures to be made.

As the plan looks to a radical improvement of the river, it has been deemed advisable by the War Department, upon the recommendation of the Chief of Engineers, that the plan therein recommended should receive the consideration of a Board of Engineer officers before commencing the work.

Should it be deemed essential to a better understanding of the capacity of the river for improvement, or for the collection of additional information in relation thereto, or for a knowledge of the resultant commercial advantages of the outlay involved, the Board is authorized either to detail one or more of its members to make personal inspection, or to require the attendance of Captain Taber, or both.

The Board is desired to give this subject its earliest consideration consistent with its other duties.

By command of Brig. Gen. Duane.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Col. THOMAS LINCOLN CASEY,
Corps of Engineers, President Board of Engineers for Fortifications and for River and Harbor Improvements.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, March 15, 1887.

GENERAL: The Board of Engineers has the honor to present the following preliminary report upon the general subject of the navigation of Arkansas River, called for by the Department letter of November 10, 1886, in connection with the project of Captain Taber, dated September 24, 1886, for the expenditure of $44,000 appropriated by the river and harbor act of August 5, 1886.

The language of the law is as follows:

> Improving Arkansas River, Arkansas: Continuing improvement, $75,000, according to the plan and recommendations in Appendix V 13, Ex. Doc. No. 1, Forty-ninth Congress, of which there are to be expended $8,000 at Pine Bluff, $13,000 at Fort Smith, and $10,000 at Dardanelles, or so much thereof under those sums, respectively, as may be necessary at those points.

In Appendix V 13 Captain Taber presents very briefly and without discussion or elaboration a "plan for the permanent improvement" of the Arkansas River from Little Rock to the Mississippi, contemplating a channel at least 200 feet wide and 6 feet deep at low water, to be secured at an estimated outlay of $2,538,544.

The "permanent improvement" of a river implies the making of a regulated channel which can afterward be maintained by an annual expenditure small in comparison to the first cost.

In a river without permanent banks like the Arkansas, such a regulation should begin at some part of the river which can be permanently held and extend down-stream; otherwise works already constructed will be destroyed by the changes in flow created above them. This condition forms an essential part of the projected improvement of the Upper Mississippi referred to in Captain Taber's "plan." (Annual Report of Chief of Engineers for 1881, Part II, page 1534.)

Captain Taber's project of September 24, 1886, for expending this $44,000 is evidently based on the idea that such a systematic regulation of the river is to be inaugurated, beginning at Little Rock; but a study of the projected works upon which his estimate is based shows that only such isolated contraction dikes as appear needful to improve bad bars now existing are contemplated by him, and that no bank revetments covered with stone between high and low water, which are essential for permanency, are included.

The language of the act approved August 5, 1886, would seem to indicate that this systematic regulation is not obligatory in expending the $75,000 therein appropriated because $31,000 of it are ordered to be spent at three localities widely separated from each other. For these reasons the Board recommends that the balance available ($44,000) be expended at such locality or localities as shall remove the worst obstructions to navigation below Little Rock, and that, if the language of the law admits of such application, the removal of snags be included. The small amount now available if applied to begin any comprehensive system of works would afford no immediate relief, while the application proposed would accomplish desirable results without in any way interfering with a systematic treatment of the river when sufficient funds shall have been provided.

Projects accompanied by a memoir and drawings should be submitted for any proposed contraction works under this appropriation of $44,000.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
C. B. COMSTOCK,
Lieut. Col. of Engineers and Bvt. Brig. Gen.
WALTER MCFARLAND,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 25, 1887.

Respectfully submitted to the Secretary of War, with recommendation that Capt. H. S. Taber, Corps of Engineers, the officer in charge, be authorized and instructed to apply so much of the appropriation of August 5, 1886, for improving Arkansas River as may be applicable for the purpose, at such localities as will serve to remove the worst obstructions below Little Rock, and in a manner having the permanent improvement in view.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

Approved as recommended by the Chief of Engineers.
By order of the Secretary of War:

SAM'L HODGKINS,
Acting Chief Clerk.

WAR DEPARTMENT, *March* 29, 1887.

PROJECT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., April 7, 1887.

SIR: In accordance with the requirements of a letter from your office dated March 31, 1887, I have the honor to submit projects for two localities in order that work may be begun in season to secure the services of the trained men recently discharged at Pine Bluff, Fort Smith, and Dardanelle, and also in view of the fact that to use the plant at Pine Bluff for the entire work renders it imperative that work be begun promptly to complete the work before the high water of next December. The projects for other localities will follow as a whole.

The two selected are beyond question the worst. To fix upon the next worst will take considerable time.

Trusting the above will be considered sufficient grounds for this apparent piecemeal work, I proceed at once to the projects.

It is proposed to make the first expenditure at Z, on Sheet No. 1, Arkansas River, by erecting pile and brush dike, according to the tracings herewith inclosed, with a well-weighted foot mat, the dike to be 12 feet above mean low water, and from 500 to 600 feet in length, as may be necessary to accomplish the object in view, viz, to prevent the channel from leaving the draw of the Baring Cross Bridge, and to, in conjunction with Big Rock, opposite, give a stable heading to the balance of the works.

During the season immediately following the survey there was a fill of upwards of 10 feet in and below the shore side of the draw pier of the upper or Baring Cross Bridge. This continues and is due to the point of rocks at X and the caving at Y.

The worst place between Little Rock and the mouth is at "U." The river is now moving to make a caving bend at or near "V." It is plain, then, that it is of little use to attempt to correct "U" until the work at Z is erected, so as to direct the river through the draw and next to the town.

It is proposed to make the next expenditure, or rather a simultaneous one, so far as may be, at U, sheet 1, Arkansas River, in erecting two or more brush and pile dikes as may be required, and about as shown upon the maps, and 12 feet high, reckoning from mean low water

It is intended that these dikes shall remove a bar in the vicinity of "U" and "T" that now effectually prevents even boats drawing only 20 inches from reaching the city wharves.

These dikes are to act conjunctively with others eventually to be erected at or near "S," to remove a bad bar near "R."

These latter dikes will be made the subject of another communication, as "R" is not one of the worst places.

It is expected that it will require 1,000 feet of diking at U; this, with the 500 or 600 feet at "Z," will make, all told, 1,600 feet of dike.

It is estimated that it will require an expenditure of from $6 to $8 per linear foot to construct this, using the Pine Bluff plant, and presumptively such of the Fort Smith and Dardanelle plant as may be no longer needed there.

This project therefore provides for the expenditure of from $9,600 to $12,800 of the $44,000, together with any balance of the appropriation of August 5, 1886, as may not be wanted for the special localities enumerated in the act referred to in my general project prepared September 24, 1886.

It is possible that a short dike may be required below "Z," but it is hoped the object will be effected by the one at "Z."

It is proposed to reserve about $2,000 until after a rise shall have aided in settling the question definitely. This will place the superior limit of the amount to be expended at the localities specified at $14,800. It is, however, expected that by using the best men of this district, at a time when work is suspended elsewhere, that the works can be erected upon the inferior limit, viz, $11,600.

It may be noted that no provision is now made for the dikes parallel to the current. Observations upon the works erected at Pine Bluff leads me to believe that these may be omitted. It is thought best to do so for the present, in order to give immediate relief to navigation.

They may be erected at any time if found necessary.

Since preparing the above, and while waiting for the tracings to be prepared, I have ascertained that a place near Eagle Bend is practically as bad as "U." This is shown at C, on sheet 4, Arkansas River.

The maps show this to be a bad place, and changes that were going on at the time the survey was made have continued until the case is much aggravated.

Reliable information has been obtained to show that with U and C improved, the light-draught boats could immediately make regular trips at extreme low water. This, of course, would be a great gain, as there are some four or six boats of this description in the upper river.

It is proposed to erect one or more dikes as may be necessary at or near C, sheet 4, Arkansas River, for the purpose of contracting the channel at medium stage, and thus remove the bar at or near "B."

These dikes will be about 600 feet long, and should one prove sufficient, as seems very likely from the prompt manner in which this river yields to these methods, it will require but $4,800 as the superior limit to erect the same, and it is highly probable that $3,600, the (inferior) limit will be sufficient.

It is proposed to erect the dike, or dikes, in all respects similar to those already described.

The dike will be located only after a careful personal examination of the actual conditions. It is hoped that one dike will be sufficient. But one will be constructed with the present appropriation, unless it should be found absolutely necessary.

This dike, as in fact all others, will be located, however, as a part of those that will belong to the system proposed to give the deep channel as set forth in my original project.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 19, 1887.

Respectfully referred, with its inclosures, to the Board of Engineers for its information and examination, in view of the Board's preliminary report of March 15, on the improvement of this river, and for such remarks thereon with recommendation as may be deemed proper to make.

By command of Brig. Gen. Duane:

JOHN G. PARKE,
Colonel of Engineers,
Brt. Maj. Gen., U. S. A.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 29, 1887.

Respectfully returned approved subject to such modifications as will meet the views and recommendations of the Board of Engineers thereon in its report of April 25, 1887, a copy of which is herewith inclosed to be retained by Captain Taber.

* * * * * * *

By command of Brig. Gen. Duane:

CHAS. W. RAYMOND,
Major of Engineers.

REPORT OF BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, April 25, 1887.

GENERAL: The Board of Engineers to which was referred, by Department indorsement of 19th instant, the project of Captain Taber, for work at two localities on the Arkansas River, has the honor to submit its views thereon as follows:

Captain Taber has selected for improvement the two sites which in his judgment are "beyond question the worst." The Board, in the absence of an appropriation of sufficient magnitude to regulate the entire river, is of the opinion that this consideration should determine the localities where the available funds should be applied.

The maps accompanying the project of Captain Taber were made in 1884–'85, and apparently have not been corrected to exhibit the present condition of the river at the sites where work is proposed. It is therefore not possible to indicate with precision where contraction works should be placed.

The first site selected by Captain Taber is near Little Rock. The objects proposed are:

(1) To check caving just above the city, which threatens to turn the current to the left bank of the river away from the upper bridge draw and the wharves; and

(2) To remove a bad bar just below the town.

To accomplish the first object Captain Taber proposes a single spur dike at Z on sheet 1, from 500 to 600 feet long and 12 feet above mean low water, and possibly a shorter one below. This single dike is about 7 800 feet above the rocky point, which limits the caving below. Throughout the whole distance a large and growing sand-bar occupies the opposite side of the river. The first effect of the dike would be to turn the whole current upon the head of this sand-bar, and the Board is by no means confident that the ultimate effect would be to cause it to flow smoothly through the bridge draw and along the city front, as it did before the caving began, which is the object to be sought. It would appear safer and more in accordance with experience to force the current to erode the side of the bar by several spur dikes of much shorter length, located between the point where caving begins and the rocky point at X; beginning these works at the upper end and extending them downward at such distances apart, and with such lengths as experience shall dictate during the progress of construction. Very possibly it may be found advantageous to turn the heads of the dikes downstream to form short training-walls; but this should be left discretionary with the engineer in charge as the work progresses. The object proposed should be to restore the old line occupied by the bank before caving began, and it should be effected without unnecessary violence.

The bar below the city which Captain Taber proposes to remove is at a crossing in a straight reach, where contraction affords the proper remedy. His plan contemplates five spur-jetties, each about 200 feet long and 12 feet above low water. In the absence of a detailed survey the Board has only one suggestion to make as to these works, which seem to be well suited to effect the object in view. Their length should be regulated to contract the water-way to a width not less than that found in navigable straight reaches of similar slope in this part of the river.

Captain Taber's second site for proposed improvements is in Eagle Bend. Here the information and his project are extremely vague. Apparently the remarks just made respecting the bar below Little Rock are applicable here. Excessive contraction should be avoided.

The papers referred to the Board in connection with this subject are returned herewith.

Respectfully submitted.

THOMAS LINCOLN CASEY,
Colonel Corps of Engineers.
HENRY L. ABBOT,
Col. of Engineers, Bvt. Brig. Gen.
D. C. HOUSTON,
Lieut. Col. of Engineers, Bvt. Col.
W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V 6.

SURVEY OF ARKANSAS RIVER, ARKANSAS, FROM LITTLE ROCK TO ITS MOUTH.

The original plan for this survey contemplated covering the river with a series of triangles, determining the shore-line both at high and low water, the positions of the bars and islands, the general topography of the valley to the bluffs, when these are not too far from the river, the depth of the water, the gauging of the river at various points, and principal tributaries, the nature of the soil and character of the river-bed, cross sections to be made at frequent intervals, the slope to be accurately determined, and all other attainable data to be collected that will bear upon the problem of the permanent improvement of the navigation of the river.

There was expended upon the project to June 30, 1886, $18,988.80.

This had completed the field work and the maps so far as obtaining tracings of the reduced sheets.

During the fiscal year ending June 30, 1887, the balance, $308.20, has been expended in photolithographing and printing 100 copies of each of the tracings of the reduced sheets, in the care of the property and records, and in making a few special observations for discharge and to determine what changes had taken place opposite the city of Little Rock.

The original project being completed, no further funds are required.

COMMERCE.

(See Report for Improving Arkansas River, Arkansas.)

Money statement.

July 1, 1886, amount available	$308.20
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	308.20

EXPENSE ACCOUNT SURVEY OF ARKANSAS RIVER, ARKANSAS.

Pay-roll, labor, etc	$257.50
Stationery	5.15
Rent of office	40.00
Transportation	5.55
	308.20

V 7.

IMPROVEMENT OF THE PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed by snags, logs, drift piles, overhanging trees, and shoals.

The project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees, and cutting up the snags, logs, and drift.

The fall in the river is so great that nothing could be done to improve the shoals.

The only appropriation ever made for the river was that of act approved August 5, 1886, amounting to $3,500, one-half the estimate, $7,000.

During the fiscal year ending June 30, 1887, $3,306.51 have been expended, principally between the mouth of the river and Rocky Crossing, though some work was done above the latter point.

The work is completed, according to the original project, to Rocky Crossing, or about half the distance.

Picked men were employed, and every economy possible practiced. This is mentioned that it may appear how close the estimate was.

Boatmen pronounce the work to Rocky Crossing excellent. It only remains to have the balance of the estimate appropriated to insure the successful opening of the river to Danville.

There are conflicting interests upon this river, one centering in its navigation, the other in the bridge at Rocky Crossing, which I have already reported as an obstruction to navigation.

My attention has been drawn to this matter by an indorsement from the office of the Chief of Engineers.

As an engineer, my only duty is to determine whether the river is navigable above Rocky Crossing and worthy of improvement. My report of March 3, 1884, states that it is both. Further and more careful examination confirms the opinion there given.

The political economist must decide whether the bridge or the commerce is of the greater importance. To the engineer the bridge is only an accidental obstruction like the others.

The give the political economist time to settle the question, and also because the borrowed plant was required elsewhere, it was decided to suspend the thorough work at Rocky Crossing, and reserve the small balance until the further action of Congress should be known.

It is my duty to recommend that the balance originally asked for be appropriated. Its expenditure is fully warranted, and the benefits likely to accrue are very great.

COMMERCE.

When works of improvement began a boat made two or three trips a year at high water or medium stages, and brought out from 200 to 300 bales of cotton. With the improvement completed, freight rates would be reduced 50 per cent., and distance in hauling by wagon reduced 26 miles. There being no competing routes of transportation except wagons, no comparison of rates can be made.

The completion of the works as originally recommended would increase the commerce tenfold, and it is estimated by one writer that from 5,000 to 6,000 bales of cotton would be moved by river. Another writer estimates the increase at from 50 to 100 per cent.

The community generally would receive many benefits. One writer estimates that products could be marketed at one-half present cost; another states as an incidental benefit, that the freeing of the river of obstructions will reduce the overflow, thereby increasing the areas under cultivation and improving the general health of the section.

To all this may be added the facts that this stream is the only outlet to the Petit Jean Valley. This valley is very rich. The town of Danville in this valley receives over 1,000 tons of freight annually by wagons. Timber is plentiful and in great variety.

The great drawback to this section is its want of cheap transportation. The opening of the Petit Jean to navigation for five or six months would be of untold value to the entire valley.

The limits of a report of this kind forbid entering into details, but it may be stated in a general way that the total required to complete the work is insignificant compared with the results to be gained.

Money statement.

Received from sale of fuel to officer	$6.00
Amount appropriated by act approved August 5, 1886	3,500.00
	3,506.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,306.51
July 1, 1887, amount available	199.49

Amount (estimated) required for completion of existing project	$3,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	3,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT, IMPROVING PETIT JEAN RIVER, ARKANSAS.

Pay-roll, labor, etc	$2,366.19
Traveling expenses	115.30
Subsistence supplies	562.54
General supplies	89.59
Stationery	15.02
Fuel	66.37
Transportation	9.68
Rent of office	80.00
Telegraph service	1.82
	3,306.51

V 8.

IMPROVEMENT OF FOURCHE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879, under the act approved March 3, 1879.

Prior to any improvement its channel was choked with snags, logs, and drift, and heavy timber overhung its banks. Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions, though the shoals and now and then a snag that has washed in since work was suspended in December, 1882, still offer serious obstacles to navigation at medium stages of water.

The present project resulted from an appropriation in act approved August 5, 1886, of $5,000 for removing Rock Shoals, situated about 4 miles below Perryville, and provides for blasting a channel 50 feet wide and 2 feet deep through these shoals.

From the best information available when the estimate was prepared it appeared that these shoals were nearly dry at extreme low water. Actual observation at extreme low water in the execution of the works has shown never less than a foot of water. This made work slower and more expensive.

Work was begun as soon as possible after the appropriation became available, but could not be quite finished before high water came.

Four thousand one hundred and ninety-one dollars have been expended during the fiscal year ending June 30, 1887, and the most of the work completed. There remains near the head of the shoal some rock excavations, and over the lower reach a little deepening is required.

When low-water stage arrives again it is believed that the project can be completed with the funds available. It is probable that owing to the greater depth of water the full 50 feet in width may not be attained.

A practicable channel permitting boats to pass one way will, however, be secured, and as this will meet the present demands of commerce, it is not deemed advisable to recommend any further appropriation at this point at present, inasmuch, further, that it will be in better shape than the two shoals immediately below, where expenditures could be made more directly to the present benefit of navigation.

With favorable conditions it is by no means certain that good economy will not yet excavate the 50-foot channel. If so, it will represent fully

$6,500 worth for $5,000 expended, as the conditions differ very materially from what the records and common report led me to expect.

The commerce upon this river is increasing and the above expenditure will greatly aid the same.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1879, page 971:

> The valley of the Fourche Le Fevre is one of the most extensive in the State. Large quantities of lumber and cotton are brought out annually, besides grain, furs, tallow, and beeswax.
>
> There are also mines of lead, iron, and other metals in the valley, which can be profitably worked when the improvement is completed.

As to effect upon rates of insurance and freight, no data to work from. The incomplete state of the works would be against any great change.

As to effect of competing routes of transportation, there are no competing routes. What freight the steamboats do not succeed in reaching must be hauled long distances in wagons.

As to prospective advantages to commerce if completed, with this river thoroughly improved there would be a great saving of time to shippers. It would reduce the cost of transportation to that extent that new impetus would be given to the settlement of the country and largely increase its products.

As to benefits to community if completed, there are few communities in the State so dependent upon a river for transportation as the settlers of this valley. Every step in the improvement will bring direct gains and will be utilized at once. With such improvement as has already been made, over 3,000 bales of cotton are brought out annually and several hundred tons of freight are handled. One steamboat works very energetically upon this river, and takes immediate advantage of every improvement, so that the people are sure of immediate relief as soon as the channel is improved.

Money statement.

Amount appropriated by act approved August 5, 1886		$5,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,081.00	
July 1, 1887, outstanding liabilities	110.00	
		4,191.00
July 1, 1887, amount available		809.00
Amount that can be profitably expended in fiscal year ending June 30, 1889. See also supplemental report. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,650.00

EXPENSE ACCOUNT, IMPROVING FOURCHE LE FEVRE RIVER, ARKANSAS.

Pay-roll, labor, etc	$2,679.13
Subsistence stores	524.49
Transportation	230.30
Stationery	7.77
Medicine	3.20
Traveling expenses	61.53
General supplies	663.92
Fuel	20.40
Telegraph service	.26
	4,191.00

SUPPLEMENTAL REPORT.

In accordance with the requirements contained in the first indorsement made in the office of the Chief of Engineers July 2, 1887, upon a letter from Hon. J. H. Rogers, M. C., of date Fort Smith, Ark., June 20, 1887, in which he asks that the engineer officer in charge of improvement of Fourche Le Fevre River, in that State, be required to submit a report on the condition of the entire river, I have the honor to state that, in proceeding on August 17 and 18, 1886, to location of works already reported on in the body of this report, I passed over the entire navigable reach, except 3 miles, by daylight, and, in accordance with my general custom of taking personal notes upon public works, examined the works more or less critically, making pencil memorandum of more prominent facts observed.

From these pencil notes, and from special report from the assistant engineer upon the other 3 miles, I am able to state that the old work, so far as related to cutting overhanging trees, was so thoroughly done as still to remain very effective.

The snagging operations, while effective at some points, do not appear to have been so much so at others.

This appears to have been due to the captain of the snagboat operating at too high a stage of water; my predecessors, in this respect, meeting the same difficulties that I have encountered, through not being able to have the captains of the snagboats work at low stages of water. It may be noted in passing that it has been necessary to make very stringent regulations in regard to this matter upon other rivers in this State.

I noted that where the snags were most numerous in the river at low water the stumps from which overhanging trees had been cut would be from 10 to 15 feet high, revealing at once the stage at which the river had been worked.

As may be inferred from what has preceded, there are many places in the river where low-water snags offer serious obstacles to navigation. At various points along the river, not exceeding probably ten in number, serious land slides have occurred, carrying masses of willow and larger timber into the improved channel, so crowding the water over into the part of the river that is still choked with snags and logs.

In addition to these obstructions, which belong in a general way to the old work, there are three shoals, known as the May, Piney, and Indian.

The May Shoal consists of a short rock ledge, over which the water flows in two separate channels. The left channel, looking down-stream, has the proper depth in the middle, but being in the shape of a reversed arch in the cross-section it will not allow a square-bottomed flat-boat to pass. A slight amount of excavation on either side of the central line, the débris being deposited in the other channel, would entirely remove the difficulties encountered here. Of course this would give a very narrow channel, but one that boats could pass without difficulty by slowing up. The same object might be accomplished by a dam below. It would require a special study to determine which would be the least expensive. Neither could be very expensive.

It will be remembered that the notes I am working from were taken for general use, with no expectation of entering into details of this kind.

Piney Shoal is perhaps a half mile in extent, and consists of a flat ledge.

But little could be done for this except to remove a few loose rocks. It would require a lock and dam to pass even light-draught boats over this shoal.

The demands of commerce at present would hardly warrant the expense incident to this improvement.

Indian Shoals are passable whenever Piney Shoals are.

At a point known as Red Ferry a rock shaped something like a whale's back lies in such position as to render the passage of a boat dangerous. A slight outlay would move a sufficient amount of this rock to enable boats to pass with ease and safety.

All that has preceded has in mind high and medium stage of water only. Low-water navigation is out of the question except, say, for 26 miles from its mouth or up to Piney Shoals.

The removal of the obstructions enumerated would probably increase the length of the navigable season about two months.

As to the cost of removing these obstructions, it may be said in the first place that there is no use of attempting it without the construction of a new snagboat that will draw only about 15 inches of water, be hand-propelled, and capable of lifting snags of at least 75 tons, with the restriction carefully insisted on that the boat should be operated only at or near the minimum stage of water at which it could pass over the river.

The steam-propelled snagboats cost at least $2,500 per month for repairs and running expenses.

The boat that should be used on these small streams referred to above and to be seen in actual service in the *A. B. Johnson* on the St. Francis River, and the *Harry Breck* on the Red River can be run for about $800 per month.

It is believed that four months of effective service at low water would remove all the accumulated obstructions in the way of snags, logs, and drift piles, including those of the land-slides. This would also include the bowlders in Piney Shoals.

The first cost of the light snagboat is $4,000; $3,200 represents four months' work of such a boat; hence the snagging operations would cost about $7,200.

The rock excavation required is not very extensive, and would probably not exceed 250 or 300 cubic yards. Having all the plant necessary for the work now in use at a point on the river, it is probable that this rock could be removed for as low as $1.50 per cubic yard. This would make the total cost of rock excavation $450.

Briefly summarized, then, the cost of the improvement would be as follows, viz:

1 snag-boat (*A. B. Johnson* model)	$4,000
Running expenses of this boat, 4 months, $800	3,200
Excavation, 300 cubic yards rock, at $1.50	450
Total	7,650

The entire amount could be profitably expended during the fiscal year ending June 30, 1889.

V 9.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift-piles, and logs in its lower portion, and from Batesville up gravel-bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation.

The originally adopted project consisted in snagging operations, blasting of ledges and bowlders, and dam building, to remove gravel-bars or to close chutes from time to time, as appropriation warranted and commerce required.

The first separate appropriation for this river was made by act approved July 5, 1884. At the time it was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsyth, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others less dangerous, prevented any navigation at ordinary stages of water.

This river has been united so often with the St. Francis, and again once with the Black and St. Francis, and once with the Black and Little Red, that it is impossible to give exactly how much had been expended on the White River to June 30, 1884. After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000 and not over $200,000. This estimate should be given a weight 8 in a scale of 10.

The present project provides that the appropriation passed by act approved July 5, 1884, and August 5, 1886, be applied to removing snags, bowlders, and other obstructions to navigation, building wing-dams to improve shoals, repairs and care of plant, and survey of the river, as provided in the acts, with a view to its permanent improvement, from Forsyth, Mo., to the mouth.

Up to June 30, 1886, $27,063.16 had been expended. This had carried the field work of the survey from Forsyth, Mo., to Newport, Ark., a distance of 248 miles, and had removed some of the worst snags from Batesville to the mouth, and had improved the river from Batesville to Calico Rock, rendering material aid to navigation for very light-draught boats, though temporary in its nature.

During the fiscal year ending June 30, 1887, $19,512.08 were expended in the running expenses of the snagboat *Harry Sheldon* for a very short period. The greater part of this sum was expended in completing the survey from Newport to the mouth and in the expenses of an improvement party working upon the shoals from Buffalo Shoals to Batesville. This latter party was at work at the opening of the fiscal year just referred to, and continued their work until forced to suspend on account of cold weather.

The outfit for this work, consisting of a commodious quarterboat and one or more barges and the necessary tools, was floated down the river from shoal to shoal, thus saving expense for steam power. By this means a very long narrow channel was opened, having a depth of at least 2 feet* at extreme low water, at an expense that seems almost incredible when the vast amount of work absolutely done is considered. This channel may be regarded, of course, as only a temporary expedient, but as far as possible the work was done so as to be in keeping with the plans for the permanent improvement which will eventually be required. It is proposed to bring this work of improvement from Batesville to Newport, with the small balance now on hand, during the low-water season of September, October, and November, the design being to make the money go as far as possible by working at the favorable season.

The snagboat *Henry Sheldon* was operated between Newport and the mouth during December, 1886, to January 15, 1887. During this time the boat removed 166 snags, cut 2,014 trees, removed 6 drift-piles, and deadened 101 trees, taking out the worst obstructions out to deep water near the mouth of the river.

---

* Just prior to mailing this report I learn that there are several points at which this depth of 2 feet was not provided. This does not vitiate the statement in regard to the very effective work done for the money.

The field work of the survey was carried from Newport to the mouth, and the field maps nearly completed. This survey was carried on briefly as follows:

> The shore-line shall be accurately chained by one party. Another party shall traverse the river at alternate stations with stadia-line, locating shoals, rapids, and topography. Both parties shall set out by turning angles from the meridian, and must make frequent observations for variation, and record both compass-bearing and true azimuth, and take reciprocal observations on stations wherever practicable.
>
> A sounding party shall take soundings on lines at right angles to the current at points about 1,500 feet apart, these points to be marked by signal-flags to be located by the shore parties. Between these sections the sounding boat shall be kept in mid-channel, sounding at every 30 feet.
>
> Discharge sections to be taken at every 6 miles, and below and near the mouth of each tributary. Levels shall be carried along the river bank; water elevation to be taken at each sounding flag. Bench-marks to be established every mile, if practicable. All data possible relative to soil, character of river-bed, etc., to be carefully secured.

A carefully selected party, made up of men of known skill, was assigned to this work, under the immediate charge of Mr. C. E. Taft, who has carried on several economical and thorough surveys in this district.

By taking advantage of the season when the leaves are off, and also when there is the least sickness, the field work was completed early in January without accident or interruption and at the minimum expense.

From the completion of the field work to the close of the fiscal year one assistant was engaged in working up and plotting the field-notes.

Sufficient progress has been made at this to enable me to prepare plans and estimates, though the maps are not as yet in proper shape for preservation and reference.

The amount allotted for the survey, owing to the care taken in selecting the party and the time for the work, will prove more than sufficient for the completion of the maps. As provided in the act, the balance of this allotment will be applied to the general improvement of the river.

It may be noted in passing that this completes the survey of the entire river at a cost much below the original estimate, and is due to the two facts already mentioned, to which may be added a third, namely, that the appropriations were so made and expended as to be practically continuous, resulting in the economy of about 40 per cent.

It is not recommended that any further appropriations be made for the temporary improvement of the shoals, if provisions are to be made soon for the permanent improvement, plans and estimates of which follow.

With the snagging operations the case is a little different.

To make a close estimate, $8,000 will be required annually for the first two years of the permanent improvement, probably, to remove such stray snags as may accumulate. It is possible that this sum may be needed a third year, but this river being so much more susceptible to permanent improvement than the Arkansas, it is probable that two years' work on the permanent construction would stop nearly all bank caving, at least so nearly so, that by using a supply-boat, fitted with snagging appliances, the few snags met with could be removed without extra expense to the appropriation over and above that necessary to maintain such a boat for the prosecution of the works.

Plans and estimates for the permanent improvement will be ready before November 1. They could not be prepared in time to submit with this report without detriment to the other interests of the district.

Money statement.

July 1, 1886, amount available	$7,936.84	
Received from sale of fuel to officer	6.00	
Amount appropriated by act approved August 5, 1886	18,000.00	
		$25,942.84
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	19,234.14	
July 1, 1887, outstanding liabilities	277.94	
		19,512.08
July 1, 1887, amount available		6,430.76
Amount (estimated) required for completion of existing project, snagging annually		8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

EXPENSE ACCOUNTS, IMPROVING WHITE RIVER, ARKANSAS.

Pay-roll, labor, etc	$16,182.87
Subsistence supplies	2,337.07
General supplies	465.35
Stationery	47.68
Medicine	10.45
Traveling expenses	157.83
Transportation	121.36
Fuel	121.09
Telegraph service	8.28
Office rent	30.00
	19,481.98
Reserved as per letter from Chief of Engineers dated April 21, 1887	30.10
	19,512.08

V 10.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river its channel was choked with logs and snags, and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draught boats.

Its banks caved but little and, except at the shoals, it was characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm.

The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed up so as to confine the water to the main channel.

Up to June 30, 1886, $50,732.12 had been expended in carrying out the above plan.

The river as a whole, compared with the river prior to any attempts at improvements, gave evidence of persistent effort, along the general line, though too desultory, owing to the small amounts appropriated and the irregular intervals at which these appropriations were made.

By acts approved August 5, 1886, $5,000 was appropriated.

With the accurate knowledge had of the river, an application of this sum was made that gave a splendid channel, except one or more shoals, for 126 miles up the river, and work was begun looking to completing the plan so far as snags and overhanging trees were concerned, which plan contemplated work as high as Poplar Bluff, Mo.

The snagboat *Henry Sheldon*, under Capt. Henry Hennegin, by dint of great economy of time, and sound judgment as to points at which work was most required on the part of her excellent commander, succeeded in reaching a point within 68 miles of the point at which work from Poplar Bluff down was stopped a few seasons ago.

To effect this, 540 snags were destroyed, 10,130 overhanging trees were cut, 4 drift-piles were removed, and 16,004 trees were deadened, confirming Major Handbury's opinion that a light-draught boat especially equipped for this river would give the best results.

This is a very deserving river. Its waters are very much used, and since the thorough opening up is so nearly accomplished, it is most earnestly recommended that $15,000 be made available at once to complete this part of the project, and to remove as many snags as may have been carried out into the improved from the unimproved part. The sooner the unimproved river has attention, the less the expense of maintaining the improved section.

Eight thousand dollars additional is recommended for the improvement of the shoals, but if it is thought that $23,000 can not be devoted to this river, it would be the best policy to appropriate entirely for snagging, etc., that is, for any sum under $15,000, that this may be done while the snag-boat is new.

All the work was done by hired labor and the purchase of material in open market, as this was believed to be most economical and advantageous to the Government.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following statement taken from Annual Report, Chief of Engineers, 1880, page 1326:

> From the Upper Black great quantities of staves are taken, and from the Lower Black it is estimated that from 10,000 to 12,000 bales of cotton are shipped to Memphis and other markets and other shipments (amount not known) go over the Saint Louis and Iron Mountain to Saint Louis.

As to effect upon rates of insurance and freight, insurance companies have not acted upon the matter. It is expected the rates will be reduced. The work is just beginning to tell upon freight, and it is too soon to state definitely as to rates.

As to effect upon rates of competing routes of transportation, this river parallels the Saint Louis, Iron Mountain and Southern Railroad for over 100 miles. There can be no question as to water *vs.* rail transportation. Reliable parties state that the effect will be marked.

As to prospective advantages to commerce, if completed, I have been unable to get statistics from but one of the boats plying on the Black River. During 1886 it handled 27,300 tons of freight, and has contracted for 36,400 tons for 1887.

There is no computing the prospective advantages to commerce. The country is only just beginning to be opened up, and is susceptible practically of unlimited developments. It is difficult to estimate the benefits to the community if completed.

This river is one of the deepest in the State. As a natural highway it surpasses the Arkansas River. Its banks cave but little, and when the standing timber has been cleared off so that snags do not accumulate, it will not give much trouble as a navigable stream.

It is destined to become in the near future a part of a great parallel transportation line to New Orleans, competing with the Missouri Pacific system of railroads for the traffic of an immense territory.

The confines of such a report as this are too limited to do justice to this river. Were they more extended, I doubt if it were possible to forecast the great benefits that will flow from its maintenance as a navigable stream.

Money statement.

July 1, 1886, amount available	$502.78
Received by sale of fuel to officer	7.50
Amount appropriated by act approved August 5, 1886	5,000.00
	5,510.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	4,903.39
July 1, 1887, amount available	606.89
Amount (estimated) required for completion of existing project, annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	23,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT, IMPROVING BLACK RIVER, ARKANSAS AND MISSOURI.

Pay-roll, labor, etc	$3,753.98
Subsistence supplies	713.43
Traveling expenses	62.17
Fuel	153.15
Stationery	22.84
General supplies	178.59
Medicine	3.10
Transportation	14.25
Telegraph service	1.88
	4,903.39

V II.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

This appropriation was made by act approved July 5, 1884, and is the first separate appropriation made for the entire river.

Earliest appropriation made for this river under any head was made by act approved March 2, 1833. Summing up all the various works of improvement, it may be inferred that prior to 1833 this river was much choked with drift-piles, logs, and snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation.

In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs.

This river has been united so often with the White River, and also with the Black River, that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884.

After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session the approximate amount is set down as not under $70,000 or over $100,000.

small, and from the best authority I have been able to secure amounted to a few staves taken out by flatboats propelled by hand.

Good authorities, familiar with the river, state that if the river was properly improved freight would be reduced from $1 per hundred by wagon to 30 to 35 cents per hundred by boat.

From what precedes it will be seen that there are no competing public routes; the territory drained by this river is almost entirely dependent on the river for transportation.

As to the prospective advantages to commerce if completed, they are practically beyond computation. On one reach of river an expenditure of $1,500 last season resulted in 500 car-loads of merchandise being taken off the banks in less than six months, and up to the present time had increased the commerce 20 per cent. Four letters in my possession, from individuals quite widely separated, all agree upon one point, namely, that the products of the country, and hence its commerce, would be increased 100 per cent. annually were the river improved according to the present plans.

Some idea of the general benefits to be conferred upon the community by the completion of the works may be formed from the fact that, with the river only about half prepared for navigation, there was shipped in 1885 and 1886, in the extreme upper part of it, 500 tons of merchandise, 600,000 staves, and 700,000 feet of lumber.

Extending the limit a few miles lower, and we have as the present yearly commerce:

Lumber, valued at	$3,150,000
Staves, valued at	225,000
Cotton, valued at	450,000
Corn, valued at	300,000
Pork, valued at	300,000
Potatoes, valued at	100,000
Miscellaneous, valued at	300,000

From the lower two-thirds of the river, during medium and high-water stages, there is shipped weekly 25,000 bales of cotton, 250,000 sacks of cotton seed, and about 175 tons of merchandise.

Letters to support these facts will be found in my last annual report.

Comments as to benefits are unnecessary. This is one of the most deserving rivers in the State.

The people in the upper river hope that the work of this season, with the small balance on hand, will enable them to establish a river mail route.

The lower portion of the river differs to a certain extent from the upper reaches in being in indirect competition with certain railroads. The letter appended, marked A, from Mr. James D. Randall, covers such ground as may not have been covered in what precedes.

Money statement.

July 1, 1886, amount available		$64.37
Amount appropriated by act approved August 5, 1886		8,000.00
		8,064.37
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,323.40	
July 1, 1887, outstanding liabilities	807.90	
		7,131.30
July 1, 1887, amount available		933.07

Amount (estimated) required for completion of existing project annually.	$8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT, IMPROVING ST. FRANCIS RIVER, ARKANSAS.

Pay-roll, labor, etc	$4,126.44
General supplies	1,170.08
Subsistence supplies	976.22
Fuel	42.50
Telegraph service	11.55
Stationery	26.26
Traveling expenses	310.75
Transportation	451.50
Medicine	3.10
	7,118.40
Reserved as per letter from Chief of Engineers, dated April 21, 1887	12.90
	7,131.30

A.—LETTER FROM MR. JAMES D. RANDALL.

MEMPHIS, TENN., *May* 31, 1887.

DEAR SIR: Yours of the 18th instant asking for information in regard to the improvement of the St. Francis River to hand and contents carefully noted.

I am not now interested in the transportation business on that stream, and without considerable trouble to myself I could not answer your first question.

To your second question, I will say that if the St. Francis River was so improved as to admit of boats running all the year, freights would be reduced 33⅓ per cent.

To your third question, I will say that if such improvement was made the railroads would reduce their rates during low-water season from 25 to 50 per cent.

This low-water season lasts from three to four months. For that time the steamers are not now able to run on the river, and in consequence of having a monopoly at most points, the railroads advance rates. When navigation on the river is resumed by the steamers the railroads reduce rates again.

To the fourth question, I will say that shipments by river would be fully doubled if the river could be made navigable all the year.

Owing to the uncertain condition of the river which comes at the season of the year when the crops are being moved, planters and merchants sometimes make contracts with the railroads for an all-the-year rate, binding themselves to give the railroads all of their freighting for twelve months. When this is done the rate is about 25 per cent. above high-water rates by boat.

I think one of the greatest mistakes, one that cripples the work of river improvement more than any other, is in making changes of the officers in charge of the districts.

About the time one officer gets familiar with the kind of work required, etc., he is removed and a new one put in his place. I believe you will agree with me in this. * * *

Most respectfully,

JAS. D. RANDALL.

Capt. H. S. TABER,
United States Engineer.

V 12.

IMPROVEMENT OF L'ANGUILLE RIVER, ARKANSAS.

This river, like all the streams in eastern and southeastern portions of Arkansas before being improved, was obstructed by logs, snags, and overhanging trees, and the shoals incident to accumulation of snags and logs.

The original plan of improvement, begun in 1879, contemplated the removal of these obstacles, and up to June 30, 1885, $13,850.53 has been expended in such a way as to remove all obstructions to navigation at medium stages of water, leaving a balance of $3,149.47.

There was a considerable interim in the expenditure of this appropriation, due to there being no plant in this district adapted to the balance of the work, which, to be effectual, had to be done very near low water.

Towards the close of the fiscal year ending June 30, 1886, the new light-draught hand-propelled snag-boat *A. B. Johnson*, belonging to the St. Francis River and exactly adapted to this work, was transferred to this river and work begun. Up to June 30, 1886, $16,258.33 had been expended, but high water prevented the completion of the work.

During the fiscal year ending June 30, 1887, the entire balance, $741.67, has been expended. This sum, with what was expended the year before, being all expended at low water, and with a powerful boat that could be run at a minimum expense, cleared all the obstacles out of the channel from Marianna to the mouth, except for the distance of about 1 mile from the mouth up. Provision was made to work this also, but the assistant in charge and the larger part of the party was suddenly prostrated with fever, and this so demoralized the party that what might have been accomplished was by this accident placed a little beyond the amount that could be practically reached.

Eventually some provision will be required to enable boats to reach Marianna at extreme low water.

At present they are obliged to stop 3 miles below. As the interests of commerce do not warrant this outlay at present, no further appropriations are recommended.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following statement which appeared in Annual Report Chief of Engineers, 1879, page 969: "There is brought out of the L'Anguille about 25,000 bales of cotton annually, and when the improvement of the river is completed a large quantity that is now shipped by railroads and also hauled to the St. Francis will be brought out by steamboats."

As to effects of rates upon insurance and freight, the improvement reduced freight to Memphis 65 cents per bale upon cotton, and to New Orleans 20 cents per bale.

As to effect upon rates of competing routes of transportation it costs 75 cents per bale to ship cotton from Marianna to Memphis by river and $1.40 by rail; $1.45 by rail to New Orleans, and $1.25 by water; cotton-seed $3.30 per ton to market by rail, $2 by water.

As to prospective advantages to commerce if completed, the works being completed so far as the original project required, it only remains to state what the commerce now is.

In 1885-'86, 5,467 bales of cotton were shipped by river from Marianna, the head of medium stage navigation, and 3,017 bales by rail. Four thousand sacks of cotton-seed were shipped during same period. During the season there is now received by water over 5,000 tons of freight. Reference to No. 4 shows that 2,500 bales of cotton represented the trade of this river prior to its improvement. The improvement has certainly wrought great benefit to this community. This is a fair sample of what may be done for every community in this State where water-ways are being improved, with the exception that many of them have a better river to begin with.

Money statement.

July 1, 1886, amount available	$741.67
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	741.67

EXPENSE ACCOUNT, IMPROVING L'ANGUILLE RIVER, ARKANSAS.

Pay-roll, labor, etc	$484.12
Subsistence supplies	97.12
General supplies	6.60
Traveling expenses	75.45
Fuel	16.59
Telegraph service	4.09
Transportation	41.60
Hire of jack-screws	1.00
Stationery	15.10
	741.67

V 13.

RE-EXAMINATION OF THE LITTLE RIVER, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., February 7, 1887.

GENERAL: In accordance with the requirements of letters dated Office of the Chief of Engineers, Washington, D. C., September 27 and October 28, 1886, I have the honor to submit the following report upon the re-examination of the Little River, Arkansas.

It being found impossible, consistent with the interests of the works under my charge, to make this examination in person, a competent civil engineer of experience and reliability was engaged to make the examination, and from his very full report now lying before me I am able to make the following statements, viz:

This river may be said to have two distinct districts—one hilly in character, the other level and alluvial in character.

From its mouth up for a distance of 55 miles it is navigable for eight or nine months of the year, and for 35 miles of these 55 it is navigable the year round for boats drawing 3 to 4 feet of water. Beginning at its mouth the first 55 miles require no improvement to meet the demands of navigation. At the end of the 55th mile, or at Hood's Landing, the entire character of the river changes. From this point the fall is so great that the river consists of a series of holes and rocky shoals. To render it navigable at even medium stages would require an outlay so entirely disproportionate to the benefits to be conferred that it would be a waste of time to even consider the question.

In my judgment the river above Hood's Landing is not worthy of improvement. Below Hood's Landing it now meets every demand of commerce. No further action is therefore required.

The time may come when it may be desirable to make the river navigable the year round as high as Hood's Landing, but that time has not yet arrived.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JAS. C. DUANE,
Chief of Engineers, U. S. A.

V 14.

PRELIMINARY EXAMINATION OF SALINE RIVER, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., February 7, 1887.

GENERAL: In accordance with the requirements of letters dated Office of the Chief of Engineers, Washington, D. C., September 27 and October 28, I have the honor to submit the following report upon the preliminary examination of the Saline River, Arkansas, viz:

Having in my possession full data in regard to this river from Big Island to its mouth, it only remained to examine it from this point some 60 miles further up-stream, or to that point beyond which its navigation should be found impracticable.

It being found impossible, consistent with the interests of the works under my charge, to make this examination in person, a competent civil engineer of experience and reliability was engaged to make the examination, and from his very full report now lying before me I am able to make the following statements, viz:

There is only water enough in this reach for navigation from February to about June 1. It is only a question of water, as there are no obstructions except the railroad bridge* already made the subject of special report in another communication.

A very careful examination was made, but as there could be nothing done to increase or prolong the supply of water, it does not seem desirable to enter into details. In fact I incline to the opinion that the examination was intended more for the lower reaches. As I had the facts for these reaches fresh to hand, it seemed best to complete the reconnaissance of the entire navigable reach and thus have upon record data concerning the entire river.

As to the reach from Big Island to the mouth, a distance of 260 miles, my annual report for 1885, page 1598, Annual Report Chief of Engineers, 1885, states that work was completed upon this reach December 20, 1884, and that the river was left in good navigable condition at medium stages as high as Longview, and at high water as high as Mount Elba (a point within the reach recently, *i. e.*, above Big Island). As to the necessity of further improvement of the reach from Big Island to the mouth, on page 1598, Annual Report Chief of Engineers, 1885, after careful consideration, I state—

> That this stream will at some time be a valuable artery of commerce there seems little room for doubt; but at present the country is not sufficiently settled. It would seem advisable, now that it is pretty well cleaned out, to watch the result in the way of developing the country before another appropriation is made. For a year or two the river will remain in its present condition, and this will give time to see whether it will be improved by the boats, and then from $5,000 to $6,000 a year could be profitably expended in securing an open river as far up as Driftwood.
>
> While, therefore, no appropriation is recommended for the year ending June 30, 1887, the question of further improvement is left contingent upon the results of the work done so far.

Again, on page 1388, Annual Report Chief of Engineers, 1886, I state—

> That there was expended on this river up to June 30, 1885, $20,951.70. This has given much relief to navigation, and has practically cleared the river so far as present navigation demands.
>
> Until the requirements of commerce are greater than they are now, it is not recommended that any further appropriation be made.

---

*The railroad bridge is owned and used by the Saint Louis, Arkansas and Texas Railroad Company, and is an obstruction to the free and safe navigation of the river from February 1 to June 1. This bridge is near Rison, Ark., and does not seem to have been constructed in accordance with the terms contained in act approved June 27, 1882, Forty-seventh Congress, first session, chap. 240.

From all that precedes, the situation of the river as a whole, for 320 miles that it is navigable, is such that I do not feel warranted in making any recommendations for further survey, nor for the expenditure of any further money for improvements.

The records of this office are so kept that the engineer in charge will be able to see that it was expected that the reach below Big Island would require attention in the future.

This will enable the Congress of the United States to afford aid to this section at once when required by the future development of the section, a matter to be determined from commercial statistics and boats using the river. At present only one boat uses the river and it makes but one trip a year.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JAS. C. DUANE,
Chief of Engineers, U. S. A.

V 15.

PRELIMINARY EXAMINATION OF CACHE RIVER, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 22, 1887.

GENERAL: In accordance with the requirements of letters dated Office of the Chief of Engineers, Washington, D. C., September 27 and October 28, I have the honor to submit the following report upon the preliminary examination of the Cache River, Arkansas.

It being found impossible, consistent with the interests of the works under my charge, to make this examination in person, a competent civil engineer of experience and reliability was engaged to make the examination, and from his very full report now before me I am able to make the following statements, viz:

No further examinations will be necessary to enable me to submit plans and estimates for the improvement of the navigable reach of this river.

It is worthy of improvement, and the outlay necessary for the same is fully warranted by the interests involved.

It appears that there are 70 miles of this river from its mouth to Riverside that are navigable, with more or less difficulty, for about seven months of the year.

Above Riverside the river becomes a swamp with numerous channels that could not be united in one without an outlay wholly disproportionate to the benefits to be conferred.

There is a river trade along the 70 miles in question amounting to 8,000 bales of cotton annually and 2,184 tons of freight. The timber is large and clear and abundant, and would alone warrant the outlay.

A railroad runs through the section, but its freight rates are so high that it disheartens producers.

Experience in this State has shown that similar rivers, when cleared of snags and drift, have added to the material prosperity of the section involved in such a way as to be susceptible of proof from the records.

All that is requisite is to free the river of snags, logs, and drift piles.

The L'Anguille River was similarly choked a few years ago. Before being cleared its commerce was represented by 2,500 bales of cotton.

After being cleared, commerce now amounts to 5,467 bales of cotton, 4,000 sacks of cotton seed, and 5,000 tons of freight. And this was only on a 10-mile reach of river.

Other rivers might be mentioned with similar figures.

With the foregoing in view it is recommended that $7,000 be appropriated for improving this river from Riverside to its mouth, to be applied as follows, viz:

For building and equipping one small hand-propelled snagboat	$3,000
For running expenses of this boat five months, at $800 per month	4,000
Total	7,000

Before closing this report it is my duty to invite attention to the fact that two railroad bridges span this river unprovided with draw-spans, and so low as to present an impassable obstacle to navigation. One belongs to the Memphis and Little Rock Railroad Company and the other to the Missouri Pacific system, being on a line from Memphis, Tenn., to Bald Knob, Ark.

These structures will be made subjects for report, as required by law. They will have to be altered before the improvement can be successfully carried out.

It is presumed there will be no difficulty in this matter, as the policy of the railroads in this State seems to have been to erect these bridges and operate them just as long as they should be undisturbed, and comply with the law when navigation demanded the passage of boats.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JAS. C. DUANE,
Chief of Engineers, U. S. A.

V 16.

PRELIMINARY EXAMINATION OF LITTLE RIVER, MISSOURI, FROM HORNERSVILLE TO ITS JUNCTION WITH THE ST. FRANCIS RIVER,

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 21, 1887.

GENERAL: In accordance with the requirements of letters dated Office of the Chief of Engineers, Washington, D. C., September 27 and October 28, I have the honor to submit the following report upon the preliminary examination of the Little River from Hornersville to its junction with the St. Francis River, viz:

The amount allotted for the preliminary examinations required of rivers in my district being small, considering the difficulty of reaching many of them, caused delay in securing the services of a competent assistant until the latter part of December. From a very full report made to me of the result of this examination, I am able to state that no survey will be necessary to submit plans and estimates for the improvement of this reach of river. It is worthy of improvement, and the outlay necessary to this improvement is fully warranted by the interests involved.

It appears that this reach of lake and river is navigable with more or less difficulty for six months in the year; also that in this condition there is shipped from Hornersville about 20,000 bales of cotton, 500,000 bushels of grain, and a considerable amount of stock.

This is the only outlet this section has except wagons. Like many other streams in this State, it has upon its banks some very fine timber, which only waits a free water-way to find a ready market.

Hornersville is backed by a large tract of improved country, whose main distributing point it is. The water-way itself is partly a lake and partly two narrow rivers. The lake extends about 12 miles from Hornersville. This lake is drained into the St. Francis River by two chutes that are known together as Little River.

At extreme low water there is less than a foot of water in the lake on an average, so that all low-water improvement is out of the question.

The most that can be done is to prolong the period of medium stage of water and remove the snags, logs, and drift-piles that have accumulated in the channel. It is proposed to accomplish the first by closing one of the chutes. This will probably indirectly aid the second, since it will increase the current in the undisturbed chute and prevent the lodgment of quite so much drift.

Residents of the section estimate that if one chute were closed the time that the river and lake could be navigated to Hornersville would be increased from six months, as now, to eight months.

There is now upon the St. Francis River an excellent snagboat, well adapted to this work, and which doubtless could be spared a few months from the St. Francis work.

A close estimate as to the cost of making the improvement as indicated above would be about as follows:

For building a dam 300 feet long, at $5 per linear foot	$1,500
Running expenses of a hand-propelled snagboat eight months, at $800	6,400
Total	7,900
Add for contingencies	100
Grand total	8,000

The above sum, judiciously expended, will afford great relief to navigation, and will give a reasonably good channel for the entire distance in question, viz., 65 miles.

It is therefore recommended that improvements to this extent be made. From experience had in the State with other rivers of this character I am able to say that the returns will be immediate, and the community will be quick to take advantage of the improved water-way.

It should be borne in mind that this is a close estimate.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

V 17.

PRELIMINARY EXAMINATION OF ST. FRANCIS RIVER FROM GREENVILLE, MISSOURI, TO THE ARKANSAS STATE LINE.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 18, 1887.

GENERAL: In accordance with the requirements of letters dated September 27 and October 28, 1886, Office Chief of Engineers, Washington, D. C., I have the honor to submit the following report upon the preliminary examination of the St. Francis River, from Greenville to the Arkansas State line, viz:

The amount allotted for the preliminary examination required of rivers in my district being small, considering the difficulty of reaching many of them, caused delay in securing the services of a competent assistant until the latter part of December.

From a very full report made to me of the result of this examination, I am able to state that no survey will be necessary to submit plans and estimates for the improvement of this reach of river.

It is worthy of improvement, and the outlay necessary to this improvement is fully warranted by the interests involved.

For the first 12 miles from Greenville towards the Arkansas State line there are a series of shoals, having a total fall of about 2 feet. The pool next to Greenville is 4 feet deep at low water. The removal of these shoals would give relief to navigation, affording about 2 feet of water at low water. Some snags and overhanging trees need removing in this reach. The balance of the reach examined is choked with drift piles, overhanging trees, snags, and has some shoals, due to drift. There is an average depth of 3 feet at extreme low water. The shoals will disappear when the snags and drift material are removed.

The total distance from Greenville to the head of the present improvements, Saint Francis, is 97 miles.

The only serious obstructions to navigation are two railroad bridges, one at Popland, owned by the St. Louis, Iron Mountain and Southern Railway Company, and the other at Saint Francis, owned by the St. Louis, Arkansas and Texas Railway Company. These structures are without draw-spans, and their lower chords are too low to allow a steamboat to pass under.

To render this reach navigable it is recommended that the shoals below Greenville be cut out, and that the snags, overhanging trees, and drift piles be removed, and for this work the following estimate is submitted:

Removal of 3,000 yards of gravel and sand-shoals, at 30 cents per yard	$900
Running expenses of the snagboat *A. B. Johnson* (belonging to this river) for eight months, at $800 per month	6,400
Total	7,300

PRESENT COMMERCE.

There is raised annually in the section that seeks transportation by this route 5,000,000 bushels of corn and about 15,000 bales of cotton. This has to be hauled 30 or 40 miles on wagons to market now. The section is heavily timbered, and contains large quantities of fine oak, ash, gum, and sycamore timber. This latter is being secured by furniture dealers and cigar-box factories in large quantities. The timber alone would warrant double the outlay.

PROSPECTIVE COMMERCE.

It is difficult to forecast prospective commerce, since this country is rapidly settling, and is like a new country in development. In my opinion, it is likely to treble itself in five years if given an outlet.

GENERAL REMARKS.

This reach of river connects with that already under improvement at Saint Francis, and though the letter called for an examination to the

Arkansas State line, it was thought best to connect with the improved river, a distance of but 10 miles further, inasmuch as the examiner would have to pass over it in returning to Little Rock.

In order to get the United States snagboat up to her work it would have to be opened, and would be an item of expense. Hence the 10 miles is included in the estimate.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JAS. C. DUANE,
Chief of Engineers, U. S. A.

APPENDIX W.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS, IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS, IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS, AND OF GASCONADE RIVER, MISSOURI.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. **Removing snags and wrecks from the Mississippi and Missouri rivers.**
2. **Mississippi River between the Ohio and Illinois rivers.**
3. **Gasconade River, Missouri.**
4. **Osage River, Missouri and Kansas.**

EXAMINATION.

5. **Osage River from its mouth to Osceola, with a view to movable locks and dams, or other methods of improvement.**

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., July 30, 1887.

SIR: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1887, for the works under my charge.

Very respectfully, your obedient servant,

A. M. MILLER,
Major Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

W 1.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI AND MISSOURI RIVERS.

MISSISSIPPI RIVER.

The work for the fiscal year consisted in the removal of snags and leaning trees between the mouth of Missouri River and Vicksburg, Miss. The river was divided into two districts or "beats," the first extending from the mouth of the Missouri River to Memphis, Tenn., and the second from Memphis to Vicksburg, Miss. The snagboat *H. G. Wright* was assigned to work in the first district, and the snagboat *John N. Macomb* to the second district.

The *Wright* began work on October 15, and continued at work until the weather became too severe for further operations, when she was called in and laid up at Bushberg, Mo.

The *Macomb* started work at Saint Louis August 22, 1886, and on her trip down removed the most dangerous obstructions in the first district, as the *Wright* was then working in the Missouri River. She remained in commission, working the second district between Memphis and Vicksburg, until February 16, 1887, when she was laid up at Bushberg, Mo.

The work accomplished in the Mississippi River was as follows:

Name of snag-boat.	Snags pulled.		Trees cut.	Drift-piles removed.	Miles run.
	Number.	Weight.			
		Tons.			
H. G. Wright	602	9,626	1,201	4	1,577
John N. Macomb	1,428	11,742	4,068	6	2,585
Totals	2,030	21,368	5,269	10	4,162

The work accomplished by the snagboats is of great benefit to the navigation of the river. Formerly the wreck of steamboats by running on snags was a very frequent occurrence. Since the snagboats have been at work it is almost an unheard-of occurrence.

The annual changes taking place in the channel of the river cause the continual appearance of new snags, either by the scouring out of old "rack heaps" in the bottom, or the caving in of timber along the banks, and a constant and continual vigilance is required to keep the channel in a safe condition. However opinions may differ as to the utility of permanent improvements on rivers like the Mississippi and Missouri, all practical steamboatmen agree that snagboat service is an undoubted, immediate, and positive benefit and assistance to navigation, removing danger of loss, not only to enormously valuable property in the shape of boats and merchandise, but of human life as well. There are other obstructions in the Mississippi River which are a source of dread and annoyance to pilots. They are the numerous wrecks which are found, especially in the bad reaches of the river. The amount of funds available have not justified the removal of these obstructions. As they are permanent and stationary, they are of less importance than snags, but a great benefit would be conferred on navigation by their removal; and it is earnestly recommended that an appropriation of $50,000 be made for the construction of a suitable vessel or wrecking boat for their removal. The machinery of the old snagboat *De Russy* is partly available for this purpose, and should be utilized.

With the appropriation recommended for the fiscal year ending June 30, 1889, it is proposed to continue the removal of obstructions as heretofore.

ESTIMATES.

For rebuilding one wooden snagboat and fitting it up for wrecking purposes.	$50,000
For working expenses of two boats, eight months each, at $4,000 per month.	64,000
For repairs, incidental work, and contingencies	15,000
Total	129,000

Money statement.

July 1, 1886, amount available	$8,407.88
Amount appropriated by act approved August 5, 1886,	56,250.00
	64,657.88
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886,	43,583.12
July 1, 1887, amount available	21,074.76
Amount that can be profitably expended in fiscal year ending June 30, 1889	129,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

MISSOURI RIVER.

Operations on this river during the year consisted in the removal of snags and other obstructions from the channel and banks. The snagboat *H. G. Wright* began work on August 15, 1886. Owing to the extremely low condition of the river, the lowest known for many years, she was only able to work up the river as far as De Witt, Mo., the usual run being from the mouth of the river to Kansas City, and above when necessary. She returned to Saint Louis on October 12, 1886.

The work in the Missouri River should be begun in the spring as early as the stage of water will permit and before the June rise; after this has subsided the low-water work should be done. Owing to lack of funds this method could not be adopted, and a comparatively small amount of work was done, as follows:

Name of snag-boat.	Snags pulled.		Trees cut.	Drift-piles removed.	Miles run.
	Number.	Weight.			
. G. Wright	624	*Tons.* 7,611	73	9	620

Work on the new snagboat *C. R. Suter* was completed, except her quipment and final steam-fitting, which was postponed to await further ppropriation. She is a light-draught snagboat, with steel hull, and hen in commission will be able to do service in the Missouri River at ny stage above that which gives a depth of 30 inches.

Her upper works were completed under contract with Joseph D. Lawin, of Saint Louis, Mo., and final payment was made on September 18, 886.

Her engines and machinery were completed and set up under con- act with the Fulton Iron Works of Saint Louis, Mo., George W. isher, superintendent, and final payment was made on October 2, 1886.

The following gives the principal dimensions of the boat, the hull be- g what is known as the "twin-bow" or "boot-jack" pattern:

	Ft.	*In.*
ull:		
Length of hull between perpendiculars	187	0
Length of hull over all	189	6
Breadth of beam of hull amidships	52	0
Breadth of beam at transom	48	10
Breadth over guards amidships	77	6
Depth of hold amidships	7	0
Crown of deck amidships	0	5⅝
Length of well from stems to forward transom	65	0
Width of well at forward transom	5	11½
Distance between stems	30	0
Clear distance between stern-posts	47	6

Engines (compound oscillating and condensing): High-pressure cylinder, 20¼-inch diameter; low-pressure cylinder, 32-inch diameter; stroke, 4 feet; cut-off, $\frac{5}{12}$ stroke.

Boilers (3): 42 inches diameter, 26 feet long, with 4 flues 9¼ inches diameter.

Water-wheels: Diameter, 16 feet; length of buckets, 11 feet.

The benefit of the snag-boat service to the Missouri River is obvious; the necessity for the work has been set forth in the remarks on the Mississippi River. This stream is peculiarly liable to snags, as it has a constant tendency to change, and attacks its caving banks with great violence.

With the appropriation recommended for the fiscal year ending June 30, 1889, it is proposed to outfit the new snagboat and work her in the river as long as the season and funds will permit.

ESTIMATES.

For outfitting and completing snagboat	$10,000
For operating boat six months, at $4,000 per month	24,000
For repairs, incidental expenses, etc	10,000
Total	44,000

Money statement.

July 1, 1886, amount available	$43,123.89
Amount appropriated by act approved August 5, 1886	22,500.00
	65,623.89
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	59,430.35
July 1, 1887, amount available	6,193.54
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	44,000.00

W 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS.

I assumed charge of these works, relieving Maj. O. H. Ernst, Corps of Engineers, on November 13, 1886, by virtue of Special Orders No. 243, Adjutant-General's Office, Washington, October 19, 1886.

This report includes the operations for the entire fiscal year.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the Illinois River to Saint Louis, a distance of 41 miles, and 8 feet from Saint Louis to the Ohio River, a distance of 191 miles, the natural depth being in many cases from 3½ to 4 feet. The initial point of the work, for the lower portion, is Saint Louis, the program being to make the work continuous, working down-stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan for the general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below Saint Louis, the

Re

5

d width being in many cases from 1 to 1½ miles, and to protect luvial banks from erosion. The methods employed are to build w banks with the solid matter caught from the river itself by . of hurdles and revetment of the banks both new and old.

ORGANIZATION.

organization of the engineering staff during the season was as s:

pervising engineer was assigned to the general supervision of works and of the supply depot; his office was in Saint Louis, s duties were to advise and direct the resident engineers, and to pecial charge of the supply of brush and stone and of the towboat arges engaged in that work.

resident engineer was provided with quarters and an office at rk. His duties were to have immediate direction of the work of uction, to make such surveys and observations as might be re- to keep the progress map, upon which all work was to be located t as constructed, to keep the journal and other records of the to prepare pay-rolls, to render quarterly property returns, to vise the kitchen, mess rooms, and quarters, and to render weekly, hly, semi-annual, and annual reports to the officer in charge, for- ng them through the superintending engineer. The superintend- gineer was Mr. D. M. Currie. Resident engineers: At Horsetail oll's Island), Mr. W. S. Mitchell; at Twin Hollows (east and west , Mr. W. S. Mitchell, assisted during the fall season by Mr. E. D. ; at Chesley Island, Mr. John O. Holman; at Jim Smith's and ur Springs, Mr. John O. Holman, assisted by Mr. C. D. Lamb; in e of procurement of brush, Mr. J. E. Savage.

WORK ACCOMPLISHED.

ing to the small amount of funds available the work laid out for the consisted only in the extension of the Jim Smith works down- n, the new work being designated as the Sulphur Springs work, epair of damages caused by the ice, and the revetment of the s (east and west) at Twin Hollows. Plate 1 is a general map of iver between the Saint Louis Bridge and Foster's Island, a distance miles, showing the location of these places.

HORSETAIL.

e work at this locality consisted in the repair of the Carroll's d hurdle. The serious damage sustained by this hurdle from the king up of the ice in February, 1886, consisted of a break begin- 500 feet east of the angle in the hurdle and extending 1,000 feet to sand-bar, and a number of separately displaced and broken braces, gers, and piles. These last were mostly confined to the drift row. the main break no vestige of the hurdle remained except the mat- s, which was found in place. The depth of water flowing through break was about 10 feet, and the current very strong. The line was stablished without difficulty, with three rows of oak piles with es and stringers, as in the ordinary type of hurdle, and in addition hurdle was wattled to a 20-foot stage, beginning at the sand-bar extending around the angle to Carroll's Island, a distance of 2,200

In the old portion of the hurdle the wattling had been placed as high as 12-foot stage, but was found very much broken and was repaired.

All of the displaced piles, braces, and stringers were reset, and all bolts in the old work were tightened or renewed where necessary.

Work was completed April 29, when the quarterboats and outfit were removed to Pulltight, Ill., where, after taking down and loading on a barge for removal all the portable buildings at that camp, the force of laborers was discharged.

The immediate effect of wattling the Carroll's Island hurdle was to shut off the large body of water flowing back of the island and to increase the draught of the water across the hurdle below the angle where the current still endeavors to pass across the head of the island. A slight surface-cutting of the bar above the island resulted, but as the sand washed off seemed to be deposited in the passage east of the island, no serious damage was done.

The condition of the hurdles and bars above the Carroll's Island hurdle is substantially the same as that given in the last annual report, the only change observed being the loss of about 40 feet of piling at the outer end of secondary hurdle No. 32, and a general deterioration in the condition of the wattling in all the hurdles, due in great part to gradual decay.

The works at Horsetail have succeeded in obtaining the result required, that is, a channel depth of not less than 8 feet. The contraction of the channel to 2,500 feet is gradually taking place and will no doubt be accomplished in the near future.

This was formerly one of the worst places below Saint Louis, but now the boats navigating the river find no difficulties here.

Plate No. 2 shows the condition of the work on June 30, 1887.

TWIN HOLLOWS.

East bank.—The work here consisted in the repair of revetment.

No work had been done in this locality since the fall season of 1884, at which time the primary hurdle and secondary hurdles Nos. 1, 4, and 5 were repaired, and the works generally were in good condition.

After the high water had passed, an examination of the bank at this place showed that the stone-work in the revetment was broken and needed repairs for half a mile below a point about opposite to the Upper or North Twin Hollow on the west bank, and, in addition, that the two large circular caves which were in this section of the bank, and which had previously been revetted, had been seriously enlarged, and the riprapping in them almost entirely destroyed through the slipping of the bank.

In the repairs the stone was removed wherever necessary and after grading the bank it was replaced, and if insufficient to thoroughly revet the spot, it was supplemented with new stone.

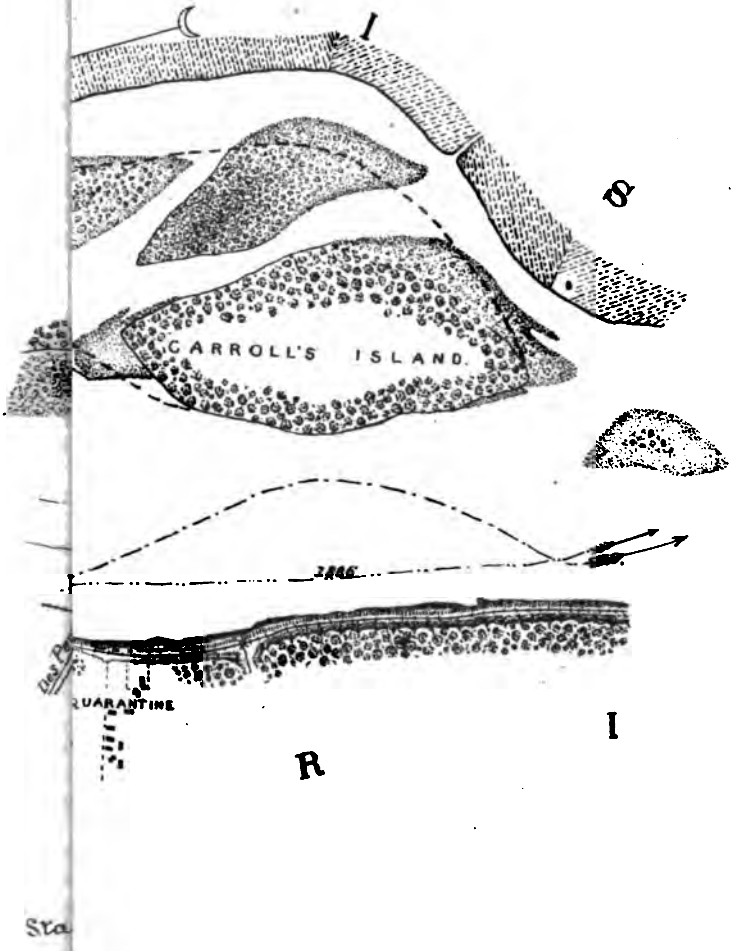
The outer edges of the caves and all projecting points were graded away and brought to a slope 2:1, that the bank might present as even a surface as possible to the water flowing over it at higher stages. The surfacing of stone was made very heavy, each stone being carefully placed in position. The revetment was brought to the 20-foot contour above low water.

These repairs were begun November 1, and were completed November 20, when the quarterboat and force of 40 men which had been employed were removed to Twin Hollows, west bank.

When this work was first contemplated it was intended, in addition, to raise the stone-work immediately below this section of the bank from

PLATE II.

ILLER, Corps of Engineers. 1887.



14 feet, to which it has been completed, to 20 feet above low water, and to thoroughly protect with stone from the edge of the low-water mattress to the latter height the section of bank lying between the down stream end of the 14-foot stone-work and the head of the primary hurdle at Pulltight, but owing to the shortness of the season and the scarcity of laborers at the west bank it was decided to postpone this work, which was not of immediate necessity, and to transfer the force to the west bank.

In the repairs indicated 2,828 cubic yards of earth was graded from the bank, and 61,268 square feet of the bank was revetted with 2,058.41 cubic yards of new stone, and 10,000 square feet additional was revetted with stone removed from the bank and replaced.

West Bank.—The work at this point consisted in the revetment of the artificial bank which had been formed by accretion works. The river showing a tendency to cave the bank at the head of the work, it was determined to revet this portion. This erosion had been going on for over a year, and is due to the growth of a bar on the west side of the lower end of Carroll's Island, which throws the current of the river against the Twin Hollows hurdles. To stop this erosion it was determined to revet the bank thoroughly, beginning at the head of the works and working down-stream as far as the short season would permit.

The necessary plant, consisting of quarterboats, waysbarge, pile-driver, etc., which had been in use at Cairo, Ill., was brought to Twin Hollows October 24, and the construction of a low-water mattress was at once begun. The head of the mattress was located immediately below the wreck of the old crib-work and against the bank 200 feet inside the line of the primary hurdle. It followed the bank closely at distances varying from 200 feet to 300 feet from the primary line, and finally crossing outside of that line at secondary hurdle No. 1, came to an end 100 feet below the latter hurdle. The mattress was completed November 29. It was of the usual type, 120 feet in width, and with a total length of 2,633 feet. No especial difficulty was encountered ether in constructing or sinking it, although at times a want of a sufficient number of laborers and the sharp curves about the ends of secondary hurdles Nos. 0 and 1 and in the deep recesses in the bank somewhat delayed the construction. The maximum day's work was 153 linear feet, and the average about 94 feet for the season.

On November 22 a quarterboat and force of men, which were brought from east bank, began grading and riprapping the bank above the shore edge of the mattress, and at the end of the season had completed the revetment on 800 linear feet of the bank, and partially completed it for 250 feet further, or to a point 230 feet above secondary hurdle No. 0. In addition, stone was placed for 100 feet around the end of hurdle No. 0, and extending from the mattress about half-way to the top of the bank. The stone-work began on the upper side of the old cribs, at the head of the primary hurdle. It extends from the mattress, 4 feet above low water, to the top of the bank, which is here from 18 to 20 feet above that level.

In placing the riprapping the stone was laid on the bank, beginning at the low-water mattress, and extending as far as the natural slope remained 2 : 1 or less. Above that the bank was graded to the slope 2 : 1, the earth being thrown out over the stone first laid, and the riprapping was then carried to the top of the grade, the stone being placed on the hard, compact bank.

In all, 45,000 square feet of bank was revetted with stone and 1,400 cubic yards of earth was graded away.

All work was suspended December 2 on account of the extreme co weather. The heavy ice then running in the river prevented an im diate removal of all plant to the winter harbor at Bushberg, and it wa not until December 8 that this was accomplished.

Although the season was very short—about five weeks—it was ve favorable to the prosecution of the work, the river remaining throu out that time at a remarkably low stage.

This work, in connection with the works at Pulltight and Bea Island, has resulted in giving a good navigable channel, with a le depth of 8 feet. The channel is somewhat tortuous, making a rat abrupt crossing at Pulltight, but it is probable that this will be recti when the river has asssumed its stable direction.

Plate No. 3 shows the condition of the work on June 30, 1887.

CHESLEY ISLAND.

The work at this locality consisted in closing a break made by th ice and drift in the hurdle constructed in 1885 for the purpose of clo ing the chute between the island and the west bank of the river. Th break of 170 feet in length, near the middle of the hurdle, was closed the drift, which collected in large quantities against the piles, wa loaded with stone sufficient to sink it to the bottom, and an extra ro of piles was driven across the chute, just above the hurdle, to protect i from drift during high-water periods.

The following table gives the amount of work done:

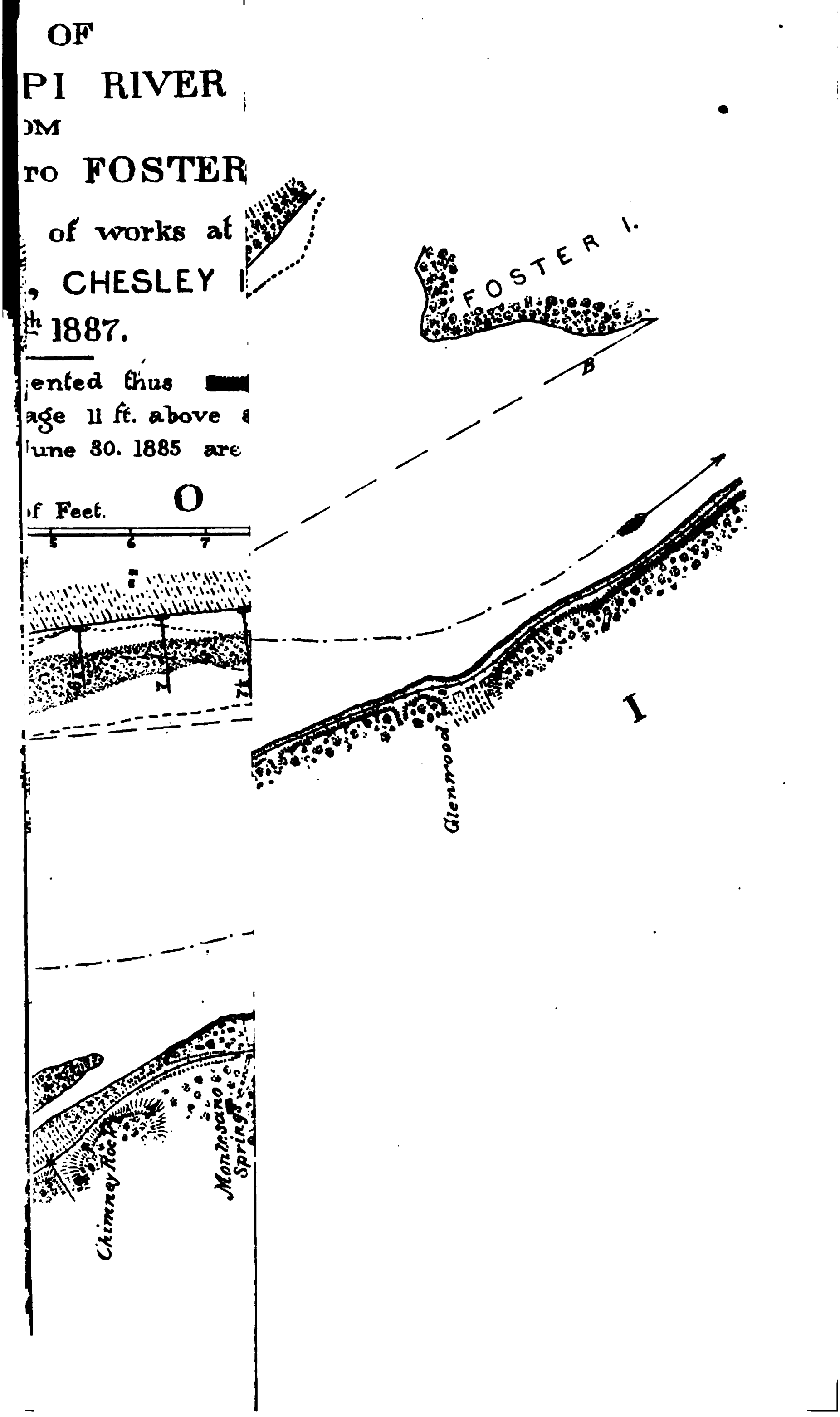
Kind of work.	Number.	Linear feet.	Squa feet.
Piles driven	253		
Braces placed	42		
Stringers placed	46		
Foundation-mattress sunk		530	42,1
Drift-mattress sunk		465	17,
Revetment placed		200	18,
Wattling placed		30	1

The piles were driven above the line of the old hurdle, as the wat through the break and below it was considerably deeper than the wat above it. Three rows were driven, 18 feet apart, the ends of the hurdl extending 30 feet beyond the break, with the brace-piles close to th drift row of the old hurdle. The piles in the drift row were driv double every 12 feet, the hurdle-piles were driven every 6 feet, and th brace-piles 12 feet apart.

Longitudinal stringers were placed on each row at the 16-foot stag with cross stringers every 12 feet, bolted to the longitudinal stringers. Braces were placed against every drift and every other hurdle-pile, all o them hung with clevises to the row below. The upper end of the bra was framed to the pile and secured to it by a three-fourths inch screw-bolt.

The foundation mattress was woven on way flats in the usual ma ner. It was built the full length of the hurdle, 50 feet in width, ex tending 15 feet above the drift row and 5 feet below the brace row. A mattress was also constructed and placed in the break to prevent furthe scour. It was 230 feet long by 110 feet in width, completely coveri the entire surface of the break, with the ends lapping on to the fo dation mattress of the old hurdle. A rise in the Meramec Riv brought a large field of drift against the hurdle just after the found

PLATE III.


OF
PI RIVER
OM
TO FOSTER
of works at
, CHESLEY
th 1887.
ented thus
age 11 ft. above
June 30. 1885 are
f Feet.
O
5
6
7
FOSTER I.
B
I
Glenwood
Chimney Rock
Montesano Springs

tion mattress was placed. A mattress from 35 to 40 feet in width, consisting of a double layer of brush, wired to poles placed 6 feet apart, was built on the drift around the new work with the ends resting on the old hurdle. Stone to the amount of 788 yards was put on this mattress, sinking the drift to the bottom, forming a solid protection up to the 11-foot stage for the new work. For a high-water protection against drift a row of piles was driven about 75 feet above the floating drift, clear across the chute, with the top of the piles left at the 22-foot stage. 6 feet higher than the hurdle. They were driven in clumps, about 16 feet apart, with three piles to a clump, the down-stream pile about 6 feet below the others and bolted to them by 1-inch screw bolts.

A slight scour in the revetment at the island end of the hurdle was repaired, and an extra layer of stone was spread over it for a length of 200 feet by 50 feet in width.

The drift-row of the hurdle, at the island end, was extended 50 feet nearer the shore and wattling placed on it as high as the stringer for a length of 30 feet, with the shore ends of the brush resting on the revetment and held in place by a layer of stone.

The season's work began April 13 and closed June 20, during which time the maximum force employed was 58.

Plate No. 3 shows the condition of this work on June 30, 1887.

The result obtained by this work is not yet demonstrated and can not be stated until the next run out of ice and high water. The effect of the work as a whole, since its conception, has been a decided fill in the chute, and will no doubt result finally in closing it.

JIM SMITH'S.

The only work done at this locality was the wattling of hurdle lines Nos. 6, 6½, 7, and 7½, from the 8-foot to the 16-foot stage, and the repairing of the wattling on No. 5½.

The amount of wattling placed on each hurdle is shown in the following table:

Hurdle line.	Linear feet.	Square feet.
No. 5½	1,000	3,025
No. 6	726	5,077
No. 6½	775	6,134
No. 7	728	6,012
No. 7½	925	8,025
Total	4,154	28,273

The brush used in wattling these hurdles was landed by the steamer *Gen. Gillmore* at the river end of No. 7½, and from there it was hauled by teams over the bar to the different hurdles as required.

Lines Nos. 6, 6½, 7, and 7½ were wattled in the order named, from the 8-foot stage, or from the surface of the bar, where the wattling previously placed was covered, to the hurdle stringer. For a distance of 155 feet on Nos. 6 and 7 the bar had formed up to the hurdle stringer.

Line No. 5½ was wattled in 1885 from the bar, which had raised to the 11-foot stage, 3 feet above the wattling placed when the hurdle was constructed, to the hurdle stringer, but during the high-water period, in the spring of 1886, the bar scoured from between the wattling, leaving a gap 1,000 feet long.

The brush remaining on hand after wattling the lower lines was used in closing this gap. The results obtained from this work have been entirely satisfactory, a large fill has been obtained, and will continue to increase. This is shown on Plate No. 3.

SULPHUR SPRINGS.

The plan for the improvement comprises a secondary hurdle every 1,000 feet from the shore to the river line E. D. C. B. (Plate No. 3), which extends from the foot of Jim Smith's to the head of Foster's Island.

Eight hurdles were constructed, Nos. 1, 3, 4, and 5 in the fall season of 1886, Nos. 6, 7, 9, and 11 in the spring season of 1887. Nos. 2, 8, and 10 were omitted. The amount of work done on each hurdle is given in the following table:

No. of hurdle.	Designed length of hurdle from bank to river line.	Piles driven.			Stringers.		Braces.	
		No.	Depth driven.	Linear feet of line.	No.	Linear feet of line.	No.	Linear feet of line.
1	1,165	588	8,406	1,290	176	1,290	285	1,2[illegible]
3	1,160	245	3,860	575	63	575	139	575
4	1,355	577	8,532	1,355	159	1,355	316	1,[illegible]
5	1,600	682	9,629	1,620	147	1,620	354	1,6[illegible]
6	1,900	820	11,492	2,320	143	2,320	289	1,735
7	1,920	773	10,974	2,120	209	2,120	337	1,9[illegible]
9	2,220	690	9,140	2,130	116	2,130	368	2,1[illegible]
11	2,550	687	9,312	2,550	178	2,550	424	2,5[illegible]
Total	13,870	5,012	71,345	13,960	1,191	13,960	2,512	13,2[illegible]

No. of hurdle.	Mattress.		Wattling.		Revetment.		Length of hurdle in good order June 30, 1887.
	Linear feet.	Square feet.	Linear feet.	Square feet.	Linear feet.	Square feet.	
1	1,220	92,720	1,290	20,800	200	15,000	1,2[illegible]
3	540	43,200	575	18,500	200	11,000	5[illegible]
4	1,300	98,800	1,355	30,000	200	13,000	1,2[illegible]
5	1,560	121,800	1,620	39,290	200	15,000	1,[illegible]
6	1,865	156,025	1,450	31,100	200	9,000	1,[illegible]
7	2,090	189,550	1,600	28,920	200	10,800	1,[illegible]
9	2,130	181,050	1,585	40,760	200	12,600	2,[illegible]
11	2,550	216,750	1,900	41,780	200	12,000	2,5[illegible]
Total	13,255	1,099,895	11,375	247,140	1,600	98,400	12,[illegible]

Driving of hurdle No. 1, the same as No.9 of Jim Smith's, was the first construction work done at Sulphur Springs. It was begun October 1, and driven a length of 1,220 feet, 100 feet beyond the river line. No. 3 was driven 540 feet from shore, leaving 600 feet undriven. No. 4 was driven full length, 1,300 feet, and No. 5 1,200 feet, 340 feet inside the river line.

Three rows of piles, from 18 to 20 feet apart, were driven in each hurdle, with the piles spaced 6 feet apart in the drift and hurdle rows and 12 feet in the brace row. Six drivers were in service a total of 1,232 hours, driving 1,834 piles a depth of 27,516 feet, an average of 1.49 piles per hour, with a depth of 15 feet for each pile driven. With shoal water and a slow current the driving was easier than usually found on contraction works.

The first work done on the resumption of work, March 21, was
closing of the gaps at the shore end of Nos. 1, 3, 4, and 5, the hi
stage of the river permitting the extension of No. 1 70 feet nearer
bank; No. 3, 35 feet; No. 4, 55 feet; and No. 5, 60 feet. Work on hur
Nos. 6 and 7 was started March 23. The driving of No. 6 was ne
completed, with the other work well up, when a rapid rise in the ri
carried away 400 linear feet of piling from the river end with 150 li
feet of floating mattress. The wreck of No. 6, with two brush-barges
several mattress-flats, lodging on the end of No. 7, carried away 250
of piling and 90 feet of floating mattress. Driving on Nos. 9 and 11
then begun, and their construction carried full length without troub
No. 11 to the river line, a length of 2,550 feet; No. 9, 2,130 feet, 100
inside of the line, where it was stopped, owing to its encroachm
on the steamboat channel. Driving on No. 7 was then resumed
the hurdle extended to the river line, a length of 2,130 feet. No. 5
also driven from the end of last fall's work to the river line, an ex
sion of 340 feet. After No. 5 was completed, the river end of N
was again driven nearly to the line, when a rise in the river carried a
185 feet of piling, but without damaging the floating mattress insid
it or the hurdle below.

The order of construction and also the form of the hurdle was so
what changed from that of last fall. (See Plate No. 5.)

The drift-piles were driven 12 feet apart, and for a distance of
to 700 feet. At the river ends they were driven double, the lower
from 2 to 4 feet below the upper one, and both bolted to the d
stringer. Only two rows, the drift and hurdle, were driven in No
and 11, and the river ends of Nos. 5, 6, and 7.

Stringers were placed on both hurdle and drift rows at about
16-foot stage. The drift stringers were generally placed while
foundation mattress was floating, but at the river ends of Nos. 6
7 it was found necessary, on account of the strong current, to p
the drift and also the hurdle stringer as the piles were driven, in o
to hold them in position. Cross stringers reaching from the drift to
hurdle row were placed every 12 feet on No. 6 for a length of 250
from the river end. A double row of cross stringers was placed on
linear feet of the river end of No. 7, one every 36 feet, bolted to
drift and hurdle stringers, and one every 24 feet, placed at the 9-
stage, bolted to both piles and to both of the braces. Braces
placed every 12 feet against the drift and hurdle rows. In the hur
having only two rows of piles the hurdle-row brace was driven in
line of the undriven-brace row from 6 to 8 feet through the matt
then pulled over to the hurdle stringer and bolted to it and to the
dle pile. Most of the drift braces were hung with clevises to the
dle piles, but a large number, especially at the shore end of Nos. 9
11, were driven through the mattress alongside the hurdle pile
pulled over to the drift row.

Where the brace row was omitted an extra flat was used in the
struction of the mattress, two being placed above the drift row,
between the drift and hurdle row, and five below the hurdle row.
the strong current at the end of the hurdles the up-stream edge o
mattress was stiffened with heavy poles, wired to it every 12 fe
prevent the mattress from breaking along the drift row while sin
it. The wattling on the upper hurdles, Nos. 1, 3, 4, and 5, was r
from the 8 to the 16 foot stage. On Nos. 6 and 7 wattling was ca
full height, from the shore end, for a length of 900 feet on No. 6,
1,150 feet on No. 7. Curtain mattresses were used in place of wat

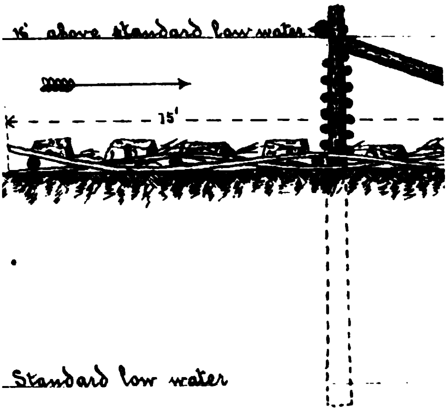


Fig. 2 - Cross Secti

The hurdles are built to the
above standard low water, in
low water. Their forms of constr
Fig. 1 shows the norma
For depths of 15' or more

109.

n the river ends of Nos. 5, 6, and 7. They were made in lengths of 00 feet, by a width of 12 to 20 feet, so that the upper edge of the mattress when launched against the drift row was at the 10-foot stage. These mattresses on No. 5 were placed on the new work to the river ine for a length of 500 feet beyond the wattling on No. 6, and 400 feet n No. 7. On No. 9 the wattling was carried full height, 1,200 feet from shore, and 385 feet beyond, only to the 10-foot stage. On No. 11 the wattling was carried full height a length of 1,900 feet. The large amount of dift accumulated on Nos. 6, 7, 9, and 11 prevented the extension of the wattling to their river ends.

The shore ends of Nos. 6, 7, 9, and 11 were protected with riprap, No. 6 only to the 16-foot stage, the others to the top of the bank.

The maximum force employed was 430. Upon the closure of the works, June 25, all the plant was transferred to the fleet at Bushberg.

The scour caused by the strong current passing under the drift, which collected on the river end of the hurdles during June, carried away 65 feet from the end of No. 4, 20 feet from No. 5, and 50 feet from Nos. 9 and 11. About 100 feet of drift row was broken on the end of Nos. 5, 7, and 9, without breaking the hurdle-row.

Plate No. 3 shows the condition of the work on June 30, 1887.

The effect produced by the works at Sulphur Springs has been, for the portion constructed last fall, a large deposit of material. The effect of the work done during the spring is not yet very apparent, as it is too recent to have as yet produced much effect; but it will without doubt, as in all similar cases, produce the desired result of narrowing the river to the required width of 2,500 feet.

CAIRO BANK PROTECTION.

Special mention of this work, with an allotment for its prosecution, has been made in the river and harbor appropriation bill, the allotment coming out of the amount appropriated for the improvement of the Mississippi River, between the Illinois and Ohio Rivers. The object of the work is the protection of the bank of the Mississippi River at Cairo, where a cut-off into the Ohio River was threatened.

An examination of this bank and the works executed for its protection was made July 22, 1886. The river, however, was at a stage marking 15¾ feet on the Cairo gauge, and exposed to view only the stone-work of the medium stage protection and those portions of the low-water mattress of 1884 which covered the spur-dikes. The stone-work was in excellent condition, very slight repairs, which could have been done by replacing the stone already there, being needed. Below the water-surface the work seemed equally good, as no evidence of a break or slip in the bank could be seen.

In September a force was organized and the plant made ready for work at Twin Hollows, but before beginning work it was transferred for duty at Cairo, in accordance with orders dated September 28. This change of plan was occasioned by the report of Mr. S. S. Taylor, of the Cairo Trust Property, dated September 27, on the probable settling of the longitudinal stone wall which connects the water ends of spur dikes Nos. 3 and 4. To repair the damage or correct such a tendency, it was thought necessary to place a mattress between these dikes outside of and overlapping the mattress of 1884, thus nearly doubling the width of the low-water protection at that place.

The steamer *Jack Frost* was chartered from the Huse and Loomis Ice Company, and, October 1, started from the harbor for Cairo, towing the barges and material necessary for the construction of the mattress, and a barge loaded with stone to sink it. At Grand Tower forty men were discharged on account of refusing to coal the steamer. This seriously crippled the force and considerably delayed the work, as it was difficult to procure good laborers, and those who were hired were unaccustomed to the work. The fleet reached the foot of Power's Island October 4, and remained there until the 9th to procure brush for the mattress; 523.46 cords were cut and loaded on barges. While procuring brush the steamer proceeded to Cairo and an examination was made of the work in question. The lower half of the wall was found intact, and the upper half did not seem to have settled, but to have had the top destroyed by ice. About 20 feet of water was found on top of this portion of the wall in the deepest place. The spur dikes and the remainder of the revetment were in good condition. The water-surface marked about 7 feet on the Cairo gauge at this time, and afforded an excellent opportunity for an examination of the works. As it did not subsequently rise above that level, it was most favorable for the construction and placing of the mattress.

The fleet reached Cairo October 10, and work was at once begun.

As no further service was required from the steamer *Jack Frost* after reaching Cairo, it was dismissed and started for Saint Louis on the 11th. The mattress was constructed without difficulty, and was sunk into place October 20. It was 544 feet in length and 120 feet in width, and extended from the third to the fourth spur dike, lapping on the mattress of 1884 and completely covering the outer slope of the longitudinal wall.

In addition about 3,500 square feet of the riprapping was repaired by resetting the stone wherever it showed a break or tendency to slip. Most of this work was done on the spurs where the stone had been slightly displaced by ice.

All work was completed October 22, and the fleet removed to Twin Hollows, Westbank, by the steamer *General Gillmore*, arriving there on the 24th. Three empty barges were left at Cairo to await the second trip of the steamer, and were brought to Twin Hollows on the 29th.

Plate No. 4 shows the condition of the work on June 30, 1887.

This work has resulted in protecting the bank, and, in connection with the changes which have taken place in the river at this point, has resulted in preventing the threatened cut-off.

PIASA ISLAND.

Work at this point consisted in the washing out a channel through a bar which had formed below the opening made in the dam for a low-water channel. This was done by the towboat *General Gillmore*, at a small expense, the cost having been $366.75.

MATERIAL.

Brush.—The brush used in the construction was procured by hired labor from the banks or islands in the river wherever convenient, a royalty of 10 cents per cord being paid to the owners of the land from which it was obtained.

In the fall season a party, consisting of thirty-five men and six teams, was organized September 22, and commenced work on the Missouri shore below Fine's Bluff on the following day. This force was grad-

of
in
C
200

ually increased to the full capacity of quarterboat No. 7, and by the second week in October consisted of forty-five laborers and fifteen teams, with the usual complement of foreman and kitchen crew.

On October 19 it became necessary to increase this force to a double capacity for a short time, in order to supply sufficient material for the mattress work about to be commenced at Twin Hollows. Barge No. 12 was fitted out at the supply depot with portable quarters and a boarding outfit, and being received on the above date, the force was increased to one hundred men and twenty-four teams.

By November 1, a sufficient surplus having been procured, the force was reduced to about sixty men, with twenty teams, and maintained at about this status until the season's work was completed, November 25.

Brush was procured during the season at Fine's Bluff, Chesley Island, Jim Smith's, Arsenal Island, Carrall's Island, and Beard's Island, and all the available brush procured at each of these localities, except a small amount on Carrall's and Beard's islands.

The weather during the entire season was very favorable, not more than four days being lost on this account.

The small amount which could be procured at each locality, necessitating the moving of the plant six times in a season of nine weeks' work, rendered progress slower than it would otherwise have been. The amount procured was 5,144.4 cords.

In the spring season the active work of procuring brush was commenced on March 16 at Foster's Island. Previous to this time a few men had been employed several days at Bushberg Harbor, preparing the quarters for occupancy and getting the plant ready for active work. On the 16th a force of fifty laborers and twelve teams, and the usual foreman and kitchen contingent, was employed.

The force was kept at about this capacity until April 25, when the force was reduced about one-third, as there was quite a surplus of brush on hand. From this date until the close of the season's work, June 10, the force of laborers averaged about thirty men, the proportion of teams varying from ten to twenty, according to the length of haul. Brush was procured at four localities, viz: Foster's Island, Calico Island, Rush Tow-head, and Harrisonville Bend. At the last-named locality, where the season's work ended, the haul became very long, being between 1½ and 2 miles. Some available brush remains at this locality, and also a small amount on Calico Island.

The weather was quite favorable, for, although considerable time was lost on account of rain, the roads over which the brush was hauled did not at any time become as heavy and impassable as is usual in the spring season.

The amount procured was 5,799.1 cords, making the total procured during the fiscal year 10,943.5 cords.

Stone was obtained from the Glenwood Lime and Quarry Association at a cost of 47⅜ cents per cubic yard. *Piles* were obtained by contract from Mr. John Cleary. *Rope, spikes, iron, nails, and screw-bolts* were obtained by contract with different parties. Other material, as needed, was obtained on bids or by purchase in open market.

Abstracts of all the bids received on formal contracts during the fiscal year are appended, and marked Appendix C.

Subsistence stores were purchased in quantities as required, a supply sufficient for fifteen days being purchased at one time, except fresh meat, which was delivered as required. The cost of subsistence was 37 cents per man per day.

SUPPLY DEPOT.

The supply depot was under the immediate charge of Mr. C. L. Steve son; the subsistence department under the direction of Mr. S. S. Va Norman. All supplies, except brush, stone, and piles, as obtained, we delivered at the depot and thence distributed on requisition to th different works. In addition to this function of the depot, it was al a general repair-shop, where all repairs to plant not requiring docka were made. During the season 18 pile-drivers were thoroughly ove hauled and repaired; 12 barges, 2 quarter-boats, 1 machine-shop, 1 ma tress-barge, 77 flats, 52 skiffs, and 36 yawls were repaired. The plant now in a good condition for resuming operations.

The present valuation of the property remaining to be distributed o installation account is given in the following table:

Class of property.	Balance July 1, 1886.	Debits.	Credits.	Balanc June 3 1887.
Barges, model, and flat	$66, 292. 91	$12, 751. 80	$20, 226. 34	$58, 818
Boat, machine-shop	1, 535. 21	480. 49	531. 44	1, 484
Boats, quarter	1, 387. 98	983. 49	594. 32	1, 777
Drivers, pile	26, 358. 17	18, 860. 57	8, 751. 74	36, 467
Flats	8, 995. 85	2, 543. 14	1, 669. 86	4, 869
Machinery, steamer *Humphreys*	6, 000. 00	370. 61	370. 61	6, 000
Shanties, portable	16, 324. 03	2, 472. 22	4, 491. 25	14, 305
Skiffs	668. 69	770. 38	716. 45	722
Steamer *General Gillmore*	16, 592. 32	16, 917. 07	17, 462. 44	16, 04
Tents	264. 94	....	52. 99	211
Ways for mattress	1, 165. 85	527. 61	608. 76	1, 084
Yawls	1, 127. 21	339. 21	600. 58	865
Supply depot	3, 395. 95	833. 81	978. 76	2, 751
Tools and appliances	1, 260. 99	1, 497. 28	1. 117. 44	1, 640
Boarding outfit	13, 575. 89	1, 127. 51	2, 326. 00	12, 377
Office furniture	625. 62	....	118. 87	506
Surveying instruments	760. 84	14. 80	159. 33	616
Photographic apparatus	275. 00	....	52. 25	222
Total	161, 607. 45	59, 989. 99	60, 829. 43	160, 768

GAUGES.

The gauges at Grafton and at Gray's Point were read daily durin the season. The readings are appended, marked "D."

CONDITION OF THE RIVER.

The channel depths, as furnished by the St. Louis and New Orlea pilot association during the low-water season, are appended, marke "E."

The low-water season extended from the middle of July, 1886, till th close of navigation by the ice on January 1, 1887.

The least depth reported was 4½ feet; this was found at App Creek on September 2, 1886, the gauge-reading at Saint Louis th same day being 1.9 feet above standard low water. A depth of but feet was found at Liberty Island and Dog-Tooth Bend. The lea channel depth reported in the improved portion of the river betwee Saint Louis and Sulphur Springs, a distance of 24 miles, has been feet, thus the desired result for this portion of the river has been ar rived at; the depth here before the work of improvement was begu was frequently as small as 4½ to 5 feet.

The following extracts, taken from the annual statement of the Merchants' Exchange of Saint Louis for the year 1886, is given in this connection:

* * * * * * *

Formerly the river between Saint Louis and Cairo offered the greatest obstructions to navigation southward on account of Horse-Tail and Twin Hollows Bars, the former 5 miles and the latter 19 miles below Saint Louis. Since the improvement of these bars the channel out to Cairo has averaged 10 to 20 feet, except, as before stated, in extreme low water, enabling the southern packets and the barge line to load to their full capacity. As elsewhere stated, during the latter part of the past season, when the stage of water was unusually low, the water on these bars was 3 to 4 feet deeper than at some other points, and had these improvements not been made these bars would have virtually made navigation southward impossible.

* * * * * * *

During the year 1886 the amount of freight in tons received at and shipped from Saint Louis by the river was as follows:

	Received.	Shipped.
	Tons.	*Tons.*
Lower Mississippi River	140, 880	46, 190
Upper Mississippi River	173, 610	431, 945
Illinois River	88, 010	5, 175
Missouri River	32, 620	24, 255
Ohio River	116, 885	26, 080
Cumberland and Tennessee rivers	18, 200	25, 075
Red and Ouachita rivers		8, 195
Total, 1886	570, 205	561, 895
Total, 1885	479, 065	534, 175
Total, 1884	520, 350	514, 910

While the railroads have absorbed to a great extent the carrying trade of the country, it is an admitted fact that the Great Lakes and the Mississippi River and its tributaries exert a powerful influence as arbiters of freight rates.

* * * * * * *

The stage of the river was unusually low, there being no June rise, and from June 1 to December 31 was lower than perhaps ever before during the same months. The benefits of the work done by the Government, under the direction of Maj. O. H. Ernst, in improving the river, was practically demonstrated during the year, as pilots reported 3 or 4 feet more water at points where the work had been carried on than at other points.

ESTIMATE.

The amount which can be profitably expended during the year ending June 30, 1889, is $1,000,000. It is proposed to expend it in carrying out the programme heretofore adopted. This is, to first improve the part of the river below Saint Louis, to make the improvement continuous, beginning at Saint Louis and working down-stream, reclaiming land and building up new banks, thus reducing the river to the approximately uniform width of about 2,500 feet. Alluvial banks are to be protected from erosion. It is proposed by this means to secure a channel depth of at least 8 feet at the lowest stage. The depth is now liable to become as little as 4 feet, or even less in some places, and less than 8 feet in every place where the width is greater than 2,500. This general statement of the proposed application of the appropriation is as specific as the nature of the case will admit of. The changeable character of the river renders it impracticable to give in advance the exact localities where works will be required.

The original estimated cost of this work, as revised in 1883, was	$16, 997, 100. 00
The aggregate amount appropriated to June 30, 1887, is	3, 739, 600. 00
The amount expended to June 30, 1886, is	3, 328, 431. 87

Money statement.

July 1, 1886, amount available		$41,309.65
Miscellaneous receipts		1.88
Amount appropriated by act approved August 5, 1886		375,000.00
		416,311.53
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$193,076.63	
July 1, 1887, outstanding liabilities	7,061.88	
		200,138.51
July 1, 1887, amount available		216,173.02
Amount (estimated) required for completion of existing project		13,257,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

CONSTRUCTION ACCOUNT.

Name of work,	Expended prior to July 1, 1886.	Expended during fiscal year ending June 30, 1887.	Total cost to June 30, 1887.
Piasa Island:			
Dam	$32,333.30		$32,333.30
Dam (cutting channel)	2,750.11	$366.75	3,116.86
Alton Dam	33,623.93		33,623.93
Alton Dike	76,652.74		76,652.74
Sawyer Bend protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
Arsenal Island protection	42,599.06		42,599.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite Saint Louis	58,455.54		58,455.54
Horsetail Bar:			
Dike 1	40,549.53		40,549.53
Dike 2	23,600.26		23,600.26
Dike 3	82,692.54		82,692.54
Dike 4	41,290.11		41,290.11
Dike 5	36,933.87		36,933.87
Training-wall	80,627.03	626.25	81,253.28
Hurdles	539,582.67	9,251.41	548,834.08
Bank protection	40,993.55		40,993.55
Twin Hollows:			
West side, hurdles	248,837.82		248,837.82
West side, bank protection		19,161.31	19,161.31
East side, bank protection	125,459.57	3,460.73	128,920.30
Beard's Island:			
Primary hurdle	7,166.24		7,166.24
Bank protection	84,258.76		84,258.76
Jim Smith's hurdles	306,523.83	2,590.63	309,114.46
Pulltight	123,600.40		123,600.40
Chesley Island:			
Bank protection	64,416.04		64,416.04
Hurdles	18,691.06	9,117.55	27,808.61
Sulphur Springs hurdles		152,717.26	152,717.26
Foster's Island	44,296.02		44,296.02
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,463.85
Kaskaskia protection	66,465.62		66,465.62
Liberty Island:			
Dam	5,053.91		5,053.91
Protection	45,129.40		45,129.40
Devil's Island:			
Dike 1	65,871.17		65,871.17
Dam 1	49,848.58		49,848.58
Dam 2	16,678.30		16,678.30
Minton Point hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdle	31,930.18		31,930.18
Cairo protection	152,394.31	8,045.51	160,439.82
Expense of Board on bridge at Chain of Rocks		231.76	231.76
Survey		1,941.35	1,941.35
Total	2,937,122.21	207,510.51	3,144,632.72

PROPERTY AND MATERIAL ACCOUNT.

Class of property.	Balance July 1, 1886.	Debits.	Credits.	Balance June 30, 1887.
Steamer *A. A. Humphreys* (machinery)	$6,000.00	$370.61	$370.61	$6,000.00
Steamer *Gen. Gillmore*	16,592.32	16,917.07	17,462.44	16,046.95
Barges	66,292.91	11,800.06	19,274.60	58,818.37
Barge-flats	....	951.74	951.74	....
Pile-drivers	26,358.17	18,860.57	8,751.74	36,467.00
Ways	1,165.85	527.61	608.76	1,084.70
Quarter-boats	1,387.98	983.49	594.32	1,777.15
Quarters	16,824.03	2,472.22	4,491.25	14,305.00
Tents	264.94	....	52.90	211.95
Supply-depot	3,395.95	333.81	978.76	2,751.00
Machine-shop	1,535.21	480.49	531.44	1,484.26
Flats	3,995.85	2,513.14	1,669.86	4,869.13
Skiffs	668.69	770.38	716.45	722.62
Yawls	1,127.21	339.21	600.58	865.84
Tools and appliances	1,260.99	1,497.28	1,117.44	1,640.83
Boarding outfit	13,575.89	1,127.51	2,326.00	12,377.40
Subsistence	907.13	20,298.16	21,066.92	138.37
Whisky and cinchona	1,414.74	17.44	32.55	1,399.63
Office furniture	625.62	....	118.87	506.75
Instruments	760.84	14.80	159.33	616.31
Photographic apparatus	275.00	....	52.25	222.75
Material, piles, Saint Louis	15,422.61	22,456.01	37,358.10	520.52
Material, brush, Saint Louis	....	27,125.87	27,125.87	....
Material, stone, Saint Louis	....	16,883.40	16,526.35	354.05
Material, stone, Cairo	....	383.84	383.84	....
Material, stone, Little Rock	1,581.99	....	....	1,581.99
Manila rope	3,177.38	5,489.40	1,887.34	6,779.44
Sisal rope	1,694.17	42.08	1,255.70	480.55
Wire	1,085.52	42.20	797.30	330.42
Iron	139.32	1,115.37	1,102.26	152.43
Nails	261.86	533.04	703.72	91.18
Spikes	503.28	333.72	672.19	164.81
Bolts, drift	4.47	.06	4.53	....
Bolts, screw	60.48	1,875.73	1,769.69	166.54
Bolts, assorted	20.96	39.92	60.69	.19
Clevises	....	1,530.22	1,388.77	141.45
Lumber	798.96	3,286.72	3,714.15	371.53
Oakum	282.66	394.72	651.56	25.82
Coal	28.02	6,423.50	6,197.92	253.60
Material, miscellaneous	102.11	3,271.34	2,858.51	514.94
Washers	....	43.74	36.23	7.51
Ice	....	1,250.05	1,250.05	....
Mattress-barge	....	9.83	9.03	....
Tug *Mignon*	4,077.72	....	....	4,077.72
Jack Frost, steamer	....	1,346.55	1,346.55	....
Lost property	42,625.03	....	....	42,625.03
Profit and loss	23,487.08	1,068.11	....	24,555.19
Total	259,282.94	175,251.03	189,033.05	245,500.92

PIASA ISLAND DAM.

Steamer *Gen. Gillmore* (cutting channel)	$366.75

HORSETAIL, EAST SIDE.

Labor, material, plant, etc.	Piling (340 piles 4,590 feet).	Bracing (170 piles, 7,018 feet).	Stringing (61 piles, 2,807 feet).	Wattling (19,100 square feet).	Subsistence.	Engineering and contingencies.	Total.
Labor, superintendence, etc	$545.21	$272.72	$252.56	$543.48	$295.33	$1,722.76	$3,632.06
General expense						251.85	251.85
Telephone						119.87	119.87
U. S. Engineer office						369.99	369.99
Steamer *Gen. Gillmore*	184.33	36.87	36.87	36.87			294.94
Barges					147.84		147.84
Barge flats					6.34	5.28	11.62
Pile-drivers	604.17	149.94	217.35				971.46
Quarters					144.00	54.40	198.40
Flats	19.76	10.42	11.30	30.62			72.10
Skiffs	16.51	8.69	8.37	16.10			49.67
Yawls	5.11	3.08	3.24	9.57			21.00
Tools and appliances	8.91	4.35	4.33	10.97			28.56
Boarding outfit					151.64		151.64
Subsistence					841.34		841.34
Office furniture						4.83	4.83
Survey instruments						7.14	7.14
Brush				364.57			364.57
Piles	1,064.78	528.74	211.48				1,805.00
Manila rope	63.00	10.85					73.85
Sisal rope	30.00	20.00	15.50				65.50
Wire				.22			.22
Nails	.75	.75		1.50			3.00
Spikes	1.84	7.36	7.36	3.68			20.24
Screw-bolts		33.87	39.57				73.44
Clevises		126.84					126.84
Coal	32.62	7.07	4.72		18.55		62.96
Washers		2.28	2.28				4.56
Ice					30.20		30.20
Miscellaneous material	14.74	14.74	14.74	14.74			58.96
Surveys						13.99	13.99
Total	2,591.73	1,238.57	820.69	1,032.32	1,635.24	2,550.11	9,877.66

TWIN HOLLOWS, EAST BANK.

Labor, material, plant, etc.	Grading (2.828 cubic yards).	Riprapping (71,268 square feet).	Subsistence.	Engineering and contingencies.	Total.
Labor, superintendence, etc	$202.09	$296.47	$134.66	$57.77	$690.99
General expense				22.49	22.49
United States Engineer Office				31.13	31.13
Surveys				3.79	3.79
Telephone				38.12	38.12
Steamer *General Gillmore*	16.30	24.45	81.50		122.25
Quarter-boats			35.31		35.31
Skiffs	5.44	11.50			16.94
Tools and appliances	5.82	8.83			14.65
Subsistence			232.32		232.32
Office furniture				1.58	1.58
Survey instruments				2.46	2.46
Stone		2,212.31			2,212.31
Iron		.17			.17
Coal			10.17		10.17
Ice			7.28		7.28
Boarding outfit			18.77		18.77
Total	229.65	2,553.73	520.01	157.34	3,460.73

TWIN HOLLOWS, WEST BANK.

Labor, material, plant, etc.	Riprapping (45,000 square feet).	Mattress (315,960 square feet).	Piling (90 piles driven 1,100 feet).	Grading (1,400 cubic yards).	Subsistence.	Engineering and contingencies.	Total.
Labor, superintendence, etc	$356.42	$2,060.63	$228.50	$274.29	$520.44	$558.53	$3,998.81
General expense						125.18	125.18
U. S. Engineer Office						187.54	187.54
Surveys						21.94	21.94
Telephone						220.45	220.45
Steamer *General Gillmore*	113.89	326.00	16.30				456.10
Barges		329.51			339.62		669.13
Barge flats		53.68			53.68	150.48	257.84
Pile-drivers			440.36	43.60			483.96
Ways for mattress		239.23					239.23
Quarter-boats					100.78		100.78
Quarters		42.85			292.84	130.80	466.49
Flats		73.01					73.01
Skiffs	4.00	15.30	8.08	2.80			30.18
Yawls		96.66					96.66
Tools and appliances	6.70	57.98	2.57	4.91	1.70		73.86
Subsistence					1,232.80		1,232.80
Office furniture						9.20	9.20
Survey instruments						14.28	14.28
Brush		6,255.26					6,255.26
Piles			380.10				380.10
Stone	2,022.61	1,096.81					3,119.42
Manilla rope		32.58					32.58
Sisal rope		31.60					31.60
Wire		204.09					290.09
Nails		28.20					28.20
Spikes		28.00					28.00
Screw-bolts		3.29					3.29
Lumber		3.20					8.20
Oakum		1.25					1.25
Coal			63.28		21.02		84.30
Ice					50.63		50.63
Miscellaneous material		57.19	16.13				73.32
Boarding outfit					108.63		108.63
Total	2,503.53	11,036.32	1,155.82	825.60	2,722.14	1,418.40	19,161.31

CHESLEY ISLAND.

Labor, material, and plant.	Piling (253 piles, 3,690 feet depth).	Stringing (46 piles).	Bracing (42 piles).	Mattress (530 linear feet, 42,100 square feet).	Wattling (30 linear feet, 180 square feet).	Riprap (200 linear feet, 10,000 square feet).	Sinking drift (405 linear feet, 17,900 square feet).	Subsistence.	Engineering and contingencies.	Total.
Labor, etc	$525.69	$150.20	$91.56	$677.69	$71.76	$57.18	$996.15	$228.84		$2,799.07
General expense									$212.44	212.44
Telephone									81.17	81.17
U. S. Engineer Office									313.48	313.48
Steamer *General Gillmore*	147.46	73.73	73.73	66.36			36.87			398.15
Barges								29.40		29.40
Pile-drivers	248.85	73.08	30.87							351.80
Ways for mattress				1.93						1.93
Quarter-boats								72.10		72.10
Quarters								24.08		24.08
Flats	9.20	3.50	2.40	15.80	1.80	20.00				52.70
Mattress barge				4.42						4.42
Skiffs	12.54	2.90	.89	1.15	.69		11.04			29.21
Yawls	.23	1.60	1.60	6.30	.46	.46				10.65
Tools and appliances	6.91	2.35	1.42	14.29	1.40	1.50	14.80			42.67
Boarding outfit								137.73		137.73
Subsistence								580.52		580.52
Office furniture									4.39	4.39
Survey instruments									6.49	6.49
Brush				656.56	39.15		286.20			982.91
Piles	712.06	142.21	115.19							969.46
Stone				654.46		207.18	653.8			1,515.50
Manilla rope	172.67									172.67
Sisal rope				25.00			30.00			55.00
Wire				30.71			13.11			43.82
Nails				21.00			12.00			33.00
Spikes	4.41			16.56			14.72			35.69
Screw-bolts	16.00	24.12	5.69							45.81
Clevises			30.80							30.80
Coal	20.44	3.15	3.15					5.50		32.24
Ice								35.73		35.73
Miscellaneous material								2.00		2.00
Surveys									10.52	10.52
Total	1,876.46	476.84	357.30	2,192.23	115.26	286.32	2,068.75	1,115.90	628.49	9,117.55

JIM SMITH'S.

Labor material, equipment, etc.	Wattling (4,154 linear feet, 28,273 square feet).	Engineering and contingencies.	Total.
Labor, superintendence, etc	$1,152.80	$320.00	$1,472.80
General expense		47.27	47.27
United States Engineer Office		66.37	66.37
Surveys		8.08	8.08
Telephone		81.22	81.22
Steamer *General Gillmore*	16.30		16.30
Flats	2.87		2.87
Skiffs	6.40		6.40
Yawls	9.20		9.20
Tools and appliances	18.00		18.00
Office furniture		3.38	3.38
Survey instruments		5.24	5.24
Brush	779.37		779.37
Sisal rope	16.00		16.00
Spikes	9.80		9.80
Nails	8.33		8.33
Boarding outfit		40.00	40.00
Total	2,019.07	571.56	2,590.63

SULPHUR SPRINGS.

Labor, material, plant, etc.	Piling (5,012 piles, 14,040 feet; line driven 71,345 feet).	Bracing (2,512 piles, 13,205 linear feet)	Stringing (1,191 piles, 15,276 linear feet).	Wattling (15,563 linear feet; 247,140 square feet).	Mattress (13,395 linear feet, 1,099,915 square feet).	Riprapping (2,400 linear feet, 126,600 square feet).	Subsistence.	Engineering and contingencies.
Labor, superintendence, etc	$7, 156. 96	$4, 532. 49	$2, 705. 56	$5, 090. 07	$10,040.15	$1, 793. 07	$5, 024. 30	$5, 172. 82
General expense								2, 625. 42
U. S. Engineer office								3, 851. 94
Surveys								170. 19
Telephone								1, 551. 24
Steamer *Gen. Gillmore*	785. 85	482. 16	429. 60	339. 57	584 63	97. 58	16. 30	16. 30
Barges							35. 08	
Barge-flats	11. 27	21. 65	231. 40	23. 46	74. 08	14. 66	11. 58	150. 48
Pile-drivers	3, 75. 279	1, 883. 00	1, 073. 29					
Ways for mattress				25. 42	284. 29			
Quarter-boats							272. 22	
Quarters	51. 81	37. 86	27. 09	49. 23	105. 44	22. 75	2, 282. 11	298. 48
Mattress-barge				5. 41				
Flats	87. 20	105. 45	57. 75	459. 80	662. 03	22. 98	51. 27	
Skiffs	152. 18	105. 12	57. 00	26. 87	69. 80	9. 34		23. 18
Yawls	6. 69	17. 13	4. 18	239. 77	143. 79	17. 50		
Tools and appliances	91. 15	76. 89	46. 07	137. 47	238. 98	40. 76	12. 61	21. 57
Subsistence							12. 765. 39	
Whisky and cinchona							21. 80	
Office furniture								75. 41
Survey instruments								114. 05
Brush				3, 531. 89	15 212. 87			
Piles	20, 628. 81	8, 863. 74	4, 397. 22					
Stone				316. 10	5, 852. 04	3, 144. 79		
Manila rope	760. 52	316. 20	148. 80		310. 00			
Sisal rope	115. 05	50. 00	35. 00	207. 10	540. 00			
Wire				125. 82	395. 03			
Nails				63. 33	399. 03			
Spikes	78. 11	15. 75		65. 14	308. 14			
Screw-bolts		627. 29	897. 47					
Clevises		1, 231. 13						
Lumber		37. 50	37. 50		74. 29			56. 18
Oakum					5. 50			
Coal	498. 54	187. 08	71. 02				142. 47	11. 79
Washers		11. 37	19. 80					
Ice							660. 99	
Miscellaneous material	352. 43	31. 61	18. 91	5. 87	30. 35	5. 35	242. 14	27. 96
Boarding outfit							1, 780. 10	
Total	34, 528. 36	18, 633. 42	10, 257. 66	11, 312. 32	35, 330. 44	5, 168. 78	23, 319. 26	14, 167. 02

Labor, material, plant, etc.	Total, Sulphur Springs.	Labor, material, plant, etc.	Total Sulphur Springs.	Labor, material, plant, etc.	Total, Sulphur Springs.
Labor, superintendence, etc	$42, 115. 43	Skiffs	$443. 49	Nails	$462. 36
General expense	2, 625. 42	Yawls	429. 06	Spikes	467. 14
U. S. Engineer office	3, 851. 94	Tools and appliances	665. 50	Screw-bolts	1, 524. 76
Surveys	170. 19	Subsistence	12, 765. 39	Clevises	1, 231. 13
Telephone	1, 551. 24	Whisky and cinchona	21. 80	Lumber	205 47
Steamer *Gen. Gillmore*	2, 751. 99	Office furniture	75. 41	Oakum	5. 50
Barges	35 08	Survey instruments	114. 05	Coal	910. 90
Barge-flats	538. 58	Brush	18, 744. 76	Washers	31. 17
Pile-drivers	6, 708. 08	Piles	33, 889. 77	Ice	660. 99
Ways for mattress	309. 71	Stone	9, 312. 93	Miscellaneous material	714. 62
Quarter-boats	272. 22	Manila rope	1, 535. 62	Boarding outfit	1, 780. 10
Quarters	2, 874. 77	Sisal rope	947. 15		
Mattress-barge	5. 41	Wire	520. 85	Total	152, 717. 26
Flats	1, 446. 48				

CAIRO PROTECTION.

Labor, material, plant, etc.	Mattress (65,280 square feet)	Piling (39 piles driven 423 feet).	Riprap (3,500 square feet).	Subsistence.	Engineering and contingencies.	Total.
Labor, superintendence, etc	$682.33	$163.27	$37.95	$257.78	$953.64	$2,094.97
U. S. Engineer office					86.10	86.10
Surveys					11.49	11.49
Steamer *Gen. Gillmore*	872.05		122.25	65.20		1,059.50
Barges	166.95					166.95
Barge-flats	20.68			1.76	105.16	127.60
Pile-drivers		235.44				235.44
Ways for mattress	57.89					57.89
Quarterboats				43.90		43.90
Quarters	21.75			21.75	65.18	108.68
Flats	22.70					22.70
Skiffs	10.12	4.84				14.96
Yawls	8.28					8.28
Tools and appliances	17.53	1.33	1.10	.90	.07	20.93
Steamer *Jack Frost*				85.80	26.34	112.14
Brush	1,906.97					1,906.97
Piles		514.52				514.52
Stone	633.60		87.23			720.83
Rope, Sisal	12.50					12.50
Wire	27.14					27.14
Nails	5.60					5.60
Spikes	35.00					35.00
Bolts, screw	.48					.48
Lumber	12.85					12.85
Oakum	.85					.85
Coal		18.25		10.95		29.20
Subsistence				479.49		479.49
Ice				34.00		34.00
Miscellaneous material	25.45					25.45
Office furniture					4.80	4.80
Survey instruments					7.46	7.46
Boarding outfit				56.84		56.84
Total	4,540.72	937.65	248.53	1,058.37	1,260.24	8,045.51

RECAPITULATION.

Showing total cost of works of improvement and engineering and contingencies during the year.

Locality.	Engineering and contingencies.	Total cost.
Piaza Dam, (cutting channel)		$366.75
Horsetail, east side	$2,550.11	9,877.66
Twin Hollows, east bank	157.34	3,460.73
Twin Hollows, west bank	1,418.40	19,161.31
Chesley Island	628.49	9,117.55
Jim Smith's	571.56	2,590.63
Sulphur Springs	14,167.02	152,717.26
Cairo Protection	1,260.24	8,045.51
Total	20,753.16	205,337.40

Abstract of proposals for furnishing screw bolts, at the United States Engineer Depot, foot of Arsenal street, Saint Louis, Mo., received in response to advertisement dated September 14, 1886, *and opened September* 25, 1886, *by Maj. O. H. Ernst, Corps of Engineers.*

No.	Names and addresses of bidders.	750 (¾" by 20").		1,000 (¾" by 23").		1,000 (¾" by 26").		2,000 (1" by 22").		1,000 (1" by 24").		Total amount.
		Each.	Amount.	Each.	Amount.	Each.	Amount.	Each.	Amount.	Each.	Amount.	
		Cts.		*Cts.*		*Cts.*		*Cts.*		*Cts.*		
1	Daniel Kerwin, Saint Louis, Mo *	7.4	$55.50	8.4	$84.00	9.6	$96.00	13.9	$278	14.6	$146.00	$659.50
2	Saint Louis Bolt, Bridge, and Forge Works, Silas De Main, secretary, Saint Louis, Mo	7	52.50	7.5	75.00	9.5	95.00	15	300	15.5	155.00	677.50
3	Moran Bolt and Nut Manufacturing Company, John Moran, secretary, Saint Louis, Mo	7.65	57.38	8.925	89.25	9.56¼	95.63	15.30	306	16.575	165.75	714.01
4	A. J. Packard, Buffalo, N. Y	14.75	110.62	14.75	147.50	14.75	147.50	14.75	295	14.75	147.50	848.12
5	M. M. Buck & Co., Saint Louis, Mo., per lb †	2.5	.....	2.5	......	2.5	......	2.5	.....	2.5	....	....

* Contract awarded. † Bid is for pounds and not for each as required by specifications.

Abstract of proposals for furnishing spikes, iron, and nails, at the United States Engineer Depot, foot of Arsenal street, Saint Louis, Mo., received in response to advertisement dated September 14, 1886, *and opened September* 25, 1886, *by Maj. O. H. Ernst, Corps of Engineers.*

No.	Names and addresses of bidders.	Wrought spikes.				Round iron.				Cut nails.		Total amount.
		6,000 lbs. (8" by ⅜").		3,000 lbs. (6" by ½").		9,400 lbs. (¾" diameter).		4,000 lbs. (1" diam.).		4,000 lbs. (20 *d.*).		
		Per lb.	Amount.	Per lb.	Amount	Per lb.	Amount.	Per lb.	Amount.	Per lb.	Amount.	
		Cts.		*Cts.*		*Cts.*		*Cts.*		*Cts.*		
1	H. L. Fox & Co., Saint Louis, Mo *	2.4	$144	2.9	$87	1.79	$168.26	1.69	$67.60	2.05	$82	$548.86
2	M. M. Buck & Co., Saint Louis, Mo	2.4	144	2.8	84	1.85	173.90	1.8	72.00	2.1	84	557.90
3	Ewald Iron Company, Saint Louis, Mo †	2.65	159	3.05	91	1.8	169.20	1.7	68.00	2.25	90	577.70
4	Waterman-Campbell Iron Company, Saint Louis, Mo	2.6	156	3	90	1.85	173.90	1.75	70.00	2.25	90	579.90
5	Andrew J. Packard, Buffalo, N. Y	2.8	168	3.3	99	2.05	192.70	2.05	82.00	2.05	82	623.70
6	E. E. Souther & Bro., Saint Louis, Mo ‡	...	......	....	....	1.85	173.90	1.75	70.00	....	......	....

* Contract awarded. † Printed instruction 1 not complied with. ‡ Partial bid.

Depth of water (in feet) upon the bars between Saint Louis and Cairo.

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Twin Hollows.	Beard's Island (head).	Beard's Island (foot).	Jim Smith's.	Sulphur Springs.	Herculaneum Swashen.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Fish Bend.	Fort Chartres.	Cambria Hollow.	Turkey Island.	Ste. Genevieve Bend.	Kaskaskia Island. Fairy Island.	Saline Creek.	Pratt's Bend.
	Feet.																							
July 2, 1886	11.70	City of Natchez	Down	...	...	...	16½	...	...	...	...	10½	...	...	15	15	...	...	...		...	...	13½	...
July 3, 1886	11.	City of Baton Rouge	Down	...	...	...	13½	...	...	...	...	7½	...	...	8	9	...	...	...	16½	12	...	12	24
July 3, 1886	11.	Oakland	Down	16½		...	13½	...	...	...	...	8	15	...	12	10½	9	...	...	...	...	...	12	...
July 5, 1886	9.80	Future City	Up	...	...	...	...	...	...	...	...	6	...	...	9	10½	...	...	...	...	12	10½	10½	...
July 7, 1886	9.10	City of St. Louis	Down	...	...	...	...	...	...	...	...	6½	...	9	...	8½	...	...	...	...	10½	8½	9	...
July 11, 1886	8.10	Annie P. Silver	Down	...	...	...	...	...	...	...	...	8½	...	...	9	10½	...	...	...	...	10½	8½	7½	...
July 11, 1886	8.10	Belle Memphis	Down	13½	...	...	12		...	...	...	7½	12	...	8½	9	...	...	...	...	10½	12	8	...
July 14, 1886	7.70	City of New Orleans	Down	...	...	...	...	...	...	...	...	7½	...	9½	...		...	...	...	...	8½	...	8	...
July 14, 1886	7.70	Arkansas City	Down	...	...	...	...	...	...	...	...	...	...	...	9	10½	...	...	9	...	8½	16½	9	...
July 17, 1886	7.70	City of Cairo	Down	...	...	...	12	...	...	...	...	7	...	...	9	...	...	...	...	10½	9	...	8	...
July 17, 1886	7.70	City of Natchez	Down	...	...	...	15	...	...	...	15	8	15		8½	10½	...	9½	...	...	9½	10½	8	...
July 21, 1886	6.50	City of Baton Rouge	Down	9	...	9	9	...	...	...	...	8	12	8½	12	9	...	9	...	...	6½	12	...	...
July 25, 1886	5.60	Arkansas City	Down	10½	...	10½	9	...	...	...	12	8	12	...	9	10½	...	...	...	...	9	...	...	...
July 26, 1886	5.30	City of St. Louis	Down	10½	...	10½	10½	...	12	...	...	7	...	8	...	8½	12	...	...	...	7½	12	...	...
July 28, 1886	4.90	City of Providence	Down	...	...	...	9	...	9	...	...	6	9	8	...	9	...	10½	...	...	7	12	...	...
July 30, 1886	4.50	City of Cairo	Down	...	...	12	9	...	10½	...	9½	7	10½	8	...	8	...	...	...	8	8½	...	...	...
July 31, 1886	4.30	City of New Orleans	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10½	12	...	...
July 31, 1886	4.30	Annie P. Silver	Down	...	...	...	...	...	...	...	...	7	8½	9	13½	8½	...	...	...	9	7	12	...	...
Aug. 7, 1886	3.70	City of Baton Rouge	Down	...	...	...	...	...	...	...	...	7	7	7		7	...	7	8	...	6½	...	...	...
Aug. 7, 1886	3.70	City of Natchez	Down	9	...	8½	...	...	...	...	...	7	7½	9½	7½	8	10½	8½	9	8	9	...	...	6
Aug. 10, 1886	3.50	City of Cairo	Down	...	...	...	...	...	...	...	...	6	7½	8	...	8	10½	8	...	8	7	...	...	...
Aug. 14, 1886	3.90	General Gillmore	...	9½	14	9½	9½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 14, 1886	3.90	Annie P. Silver	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	...	...	6½	...	...	9
Aug. 15, 1886	4.80	Henry Lowrey	Down	...	...	...	...	...	...	...	...	8	8½	9½	8	8	...	9	...	...	5½	...	...	...
Aug. 18, 1886	5.30	General Gillmore	...	10½	14	9½	9½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 18, 1886	5.30	City of New Orleans	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
Aug. 19, 1886	4.90	General Gillmore	...	10½	14	10½	10½	...	10½	11	9½	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 20, 1886	4.60	......do	...	10½	13½	9½	9½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 21, 1886	4.20	......do	...	9½	13½	9½	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 27, 1886	2.50	City of Baton Rouge	Down	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5½	...	...	9
Aug. 29, 1886	2.40	City of St. Louis	Down	...	...	...	...	...	...	...	...	...	...	...		5	...	6½	...	...	5½	...	...	8½
Aug. 29, 1886	2.45	Arkansas City	Down	...	...	...	...	...	9	...	...	...	9	...	...	...	...	...	...	...	7	...	...	...
Aug. 29, 1886	2.40	R. S. Hayes	Down	...	...	8	7	...	7½	...	8	6	7	...	6	6	6	7½	...	...	6	...	...	...
Aug. 30, 1886	2.40	General Gillmore	...	8½	12	8½	8½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aug. 31, 1886	2.30	D. R. Powell	Down	...	...	...	...	...	...	...	...	...	9	...	...	7	...	...	...	...	7	...	6	...

Date.	Stage above stand-ard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Mary River.	Liberty Island.	Jones's Point.	Wilkinson's.	'76 Crossing.	Apple Creek.	Crawfords.	Moccasin Springs.	Hamburgh Bain-bridge.	Kinney Point.	Devil's Island.	Beaver Dam Rock.	Jacket Pattern.	Atherton's.	Goose Island.	Hacker's Bend.	Buffalo Island.	Saladin Towhead.	Thompson's.	Scudder's T'head.	Greenleaf's.	Abel's Towhead.	Pond Lily.	Eliza Towhead.	Greenfield's.	Cairo Point.
	Feet.																												
July 2, 1886	11.70	City of Natchez	Down	13½	....	18	....	13½	....	15	15	15	....	12	21	15	....	15	18	....	16½	18	....	....	....	....	....	....	....
July 3, 1886	11.00	City of Baton Rouge	Down	12	....	16½	....	....	....	9	8	12	....	8	12	12	....	9	18	....	....	12	18	18	....	....	....	....	....
July 3, 1886	11.00	Oakland	Down	10½	....	10½	....	....	....	8½	10	10½	....	8½	16½	9	....	10½	12	....	12	10½	....	15	....	....	....	....	....
July 5, 1886	9.80	Future City	Up	....	....	10½	....	....	9	9½	10½	10½	....	8	16½	9	....	9	13½	....	12	10½	....	....	....	....	....	....	....
July 7, 1886	9.10	City of Saint Louis	Down	....	13½	13½	....	....	....	13½	8½	8½	....	7½	13½	....	....	7½	10½	....	12	9	....	13½	....	....	....	....	....
July 11, 1886	8.10	Annie P. Silver	Down	8½	....	....	....	....	....	7½	....	9½	....	7	9	8½	....	8	10½	....	9½	9	....	....	....	....	....	....	....
July 11, 1886	8.10	Belle Memphis	Down	9	10½	10½	....	....	....	12	9	9	....	7	9	9	....	....	....	....	....	8½	....	....	....	....	....	....	....
July 14, 1886	7.70	City of New Orleans	Down	5½	8½	....	....	....	....	8½	....	9	9	....	9½	....	....	....	....	....	9	....	....	....	....	....	....	....	....
July 14, 1886	7.70	Arkansas City	Down	....	12	....	....	....	....	9	....	....	....	6½	....	9	....	6½	....	....	8	....	....	12	....	....	....	....	....
July 17, 1886	7.70	City of Cairo	Down	8½	8½	....	....	....	....	8	8	10½	9	....	9½	9	....	9½	12	....	9	7½	....	10½	....	....	....	....	....
July 17, 1886	7.70	City of Natchez	Down	7½	9	10½	....	12	....	....	8	10½	9½	....	9½	8	....	8½	12	....	8½	8½	12	10½	....	....	....	....	....
July 21, 1886	6.50	City of Baton Rouge	Down	6½	7	....	....	....	8	8	6½	9	9	7	9	8	....	8	8	10½	7	7½	....	10½	....	....	....	....	....
July 25, 1886	5.60	Arkansas City	Down	8	6½	....	....	....	....	....	....	....	5½	....	9	7½	....	7½	....	....	7½	7½	9	8	....	....	....	....	....
July 26, 1886	5.30	City of Saint Louis	Down	7	7	12	....	....	....	8	6½	....	8½	....	7½	9	....	....	10½	....	8½	....	....	....	....	....	....	....	....
July 28, 1886	4.90	City of Providence	Down	7	....	....	....	....	....	6½	7½	....	7½	....	8	6½	....	5	7	....	6½	6½	9	9	....	....	....	....	....
July 30, 1886	4.50	City of Cairo	Down	7	6½	10½	....	....	7	9	6½	8½	9	....	7	7½	....	6½	8	10½	6	6	8½	9	....	....	....	....	....
July 31, 1886	4.30	City of New Orleans	Down	....	6	9½	....	....	6	....	....	....	7	....	7½	....	....	10½	....	....	5½	6	....	12	....	....	....	....	....
July 31, 1886	4.30	Annie P. Silver	Down	....	5½	....	9	....	6½	....	5½	7	7	8	6½	8	....	7	8½	....	6	6½	9	9	....	....	....	....	....
Aug. 7, 1886	3.70	D. R. Powell	Down	....	5½	8	....	....	6	5	7½	....	8	6½	....	7	6½	6½	8	....	6	6	....	....	....	....	....	....	....
Aug. 7, 1886	3.70	City of Baton Rouge	Down	6	5½	....	....	....	6	6	6½	....	6	7	8	8	....	7	8	....	5½	....	....	....	....	....	....	....	....
Aug. 7, 1886	3.70	City of Natchez	Down	....	5	9	....	....	5½	8	....	7	6	6½	7½	7	....	7½	5½	....	6	5⅝	....	9	....	....	....	....	....
Aug. 10, 1886	3.50	City of Cairo	Down	6	5	9	....	....	5½	8½	6½	8	7	....	8	6½	....	8	....	7	5½	5½	....	8½	....	....	....	....	....
Aug. 11, 1886	3.40	City of Saint Louis	Down	6	5½	....	....	....	6	6	6	9	6½	....	6½	7½	....	7	7½	....	6	6	....	....	....	....	....	....	....
Aug. 14, 1886	3.90	Annie P. Silver	Down	6	5	9	....	....	5½	9	6	8½	6½	....	9	6½	....	7	7	....	5½	5½	....	9	....	....	....	....	....
Aug. 15, 1886	4.80	Henry Lowrey	Down	6	5	....	9	....	6	6	....	....	7	....	....	7½	....	6	8½	....	6	5½	....	....	....	....	....	....	....
Aug. 18, 1886	5.30	City of New Orleans	Down	7½	6½	....	....	....	6	6½	....	....	7	....	9	....	....	6½	8	....	7	7	....	....	....	....	....	....	....
Aug. 19, 1886	4.90	D. R. Powell	Down	....	5½	....	....	....	6	....	....	....	....	9	12	....	....	6½	....	....	7	....	....	....	....	....	....	....	....
Aug. 21, 1886	4.20	City of Cairo	Down	....	5½	....	....	....	6	7	7	....	7	....	12	7	....	6	8½	....	7	7	9	....	....	....	....	....	....
Aug. 22, 1886	3.80	City of Natchez	Down	7½	6	9½	....	....	7	8	6½	8	5½	6	8	7½	....	6½	7	....	7	6	9	....	....	....	....	....	....
Aug. 27, 1886	2.50	City of Baton Rouge	Down	6	5	....	....	....	5½	9	....	....	6	7	10½	....	....	6	8	....	6	5	8	....	....	....	....	....	....
Aug. 29, 1886	2.40	City of Saint Louis	Down	6	5½	7½	....	....	6	6½	....	....	6	6	....	....	....	5½	6	....	5½	5	....	....	....	....	....	....	....
Aug. 29, 1886	2.40	Arkansas City	Down	6	4	....	....	....	5	8	....	....	....	7½	8	6½	....	7	8	....	6	5½	....	....	....	....	....	....	....
Aug. 29, 1886	2.40	R. S. Hayes	Down	6½	5	5	9	....	6	6	6	6	....	6	6	7	....	6	6	....	5	5	....	9	....	....	....	....	13½
Aug. 31, 1886	2.30	D. R. Powell	Down	6	5	8	....	....	5½	9	....	....	6	7	....	6	....	6½	7	....	5½	5½	....	....	....	....	....	....	....

APPENDIX E.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Twin Hollows.	Beard's Island (foot).	Jim Smith's.	Sulphur Springs.	Foster Island.	Herculaneum, Swashen.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Fish Bend.	Fort Chartres.
	Feet.																	
Sept. 1, 1886	2.00	Annie P. Silver	Down	13½		6		6		9		6	6	5		6		8
Sept. 2, 1886	1.90	City of Cairo	Down	6½		7	7	8		8½		6			6½	6	7½	7
Sept. 4, 1886	2.00	Gen. Gillmore		9														
Sept. 7, 1886	2.60	Belle Memphis	Down			7	8	7½				6	9	7		8		
Sept. 10, 1886	2.60	City of Natchez	Down				9	6				6			7			8
Sept. 11, 1886	2.50	Gen. Gillmore		8½	12	8	8											
Sept. 11, 1886	2.50	City of Baton Rouge	Down				8					6		6½		6½	7	7
Sept. 14, 1886	2.10	City of Cairo	Down	8		8		8½		9		5½	8			7		
Sept. 18, 1886	2.40	Gen. Gillmore		8		8	7											
Sept. 18, 1886	2.40	Belle Memphis	Down		10½							5½				7		
Sept. 19, 1886	2.50	Annie P. Silver	Down			6		6		6		6	6		5½	6½		
Sept. 22, 1886	2.60	Gen. Gillmore		8	10½	8½	7½											
Sept. 22, 1886	2.60	Arkansas City	Down	8				8½							6	6		
Sept. 23, 1886	2.50	Gen. Gillmore		8½	10½	8½	7½	7½	9									
Sept. 24, 1886	2.50	......do		9	10½	9	7	8	9	8½	10½							
Sept. 25, 1886	2.40	......do			11	9	7½	8	9½									
Sept. 26, 1886	2.40	D. R. Powell	Down			5	7	7		6		6	6	6		6½		6
Sept. 28, 1886	3.10	Gen. Gillmore		9½	11	9½	8½											
Sept. 30, 1886	3.40	......do		9½	11	9½	8	9	9½									
Oct. 1, 1886	3.40	......do						9	9	9½								
Oct. 2, 1886	3.20	......do		10½	12	9½	9	9½	8½									
Oct. 4, 1886	3.30	......do		10½	12	9½	9	9	8½									
Oct. 5, 1886	3.40	......do		9½	12	10½	9	10½	9½									
Oct. 5, 1886	3.40	City of Baton Rouge	Down					10½				6		7		7		
Oct. 6, 1886	3.40	Gen. Gillmore		9½	12	9½	9½	10½	9½									
Oct. 7, 1886	3.30	......do		9½	12	9½	9	9½	9									
Oct. 8, 1886	3.30	......do		9½	10½	9½	9½	10½	10½									
Oct. 9, 1886	3.20	......do		9½	10½	9½	8½	10½	10½									
Oct. 11, 1886	3.20	......do		9	10½	9½	8½	9½	10½									
Oct. 12, 1886	3.10	......do		9	10½	9	8	8½	10½									
Oct. 13, 1886	3.00	......do		9	10½	9	8	8½	10½									
Oct. 14, 1886	2.90	......do		9	10½	9½	8	9	9½									
Oct. 15, 1886	2.70	......do		9½	10½	9	8	9	9									
Oct. 18, 1886	2.80	......do		9	9½	9	8	8½	8½									
Oct. 19, 1886	2.80	......do		9	9½	8½	8	8	8½									
Oct. 21, 1886	2.80	......do		9	10½	9½	7½	9	8½	9½		8	8		6	7	8½	9
Oct. 25, 1886	2.60	......do		9½	10½	9½	8	9	9½	10½								
Oct. 26, 1886	2.70	......do		9½	10½	9½	8	9	9½	10½		7½	7		6½	7	9	10½

Louis and Cairo—Continued.

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction up or down.	Turkey Island.	Saint Genevieve Bend.	Kaskaskia Island. Fairy Island.	Saline Creek.	Mary River.	Mansoce.	Liberty Island.	Jones's Point.	Wilkinson's.	'76 Crossing.	Apple Creek.	Crawford's.	Moccasin Springs.	Hamburgh Bainbridge.	Kinney Point.	Devil's Island.	Beaver Dam Rock.	Jacket Pattern.	Goose Island.	Hacker's Bend.	Saladin Towhead.	Thompson's.	Scudder's Towhead.	Greenleaf's.	Abel's Towhead.	Eliza Towhead.
	Feet.																												
Sept. 1, 1886	2.00	Annie P. Silver	Down	7	4½	....	....	6	6	5	7	...	...	5½	5½	5½	6	5½	6	9	6	5½	4½	4½	6½	....	9	..	..
Sept. 2, 1886	1.90	City of Cairo	Down	....	5	....	...	5	6½	5	....	....	....	4½	5½	6	....	5½	7	8	....	5½	7	4½	5	....	8	..	..
Sept. 7, 1886	2.60	Belle Memphis	Down	....	5½	...	....	7½	...	5½	....	....	...	5	6	7	7	6	7	9	8	6	6	5½	5	....	..	..	..
Sept. 10, 1886	2.60	City of Natchez	Down	....	....	...	...	7	6½	5½	9	....	....	5½	6½	6	....	6	7	8	7	....	6½	6½	6	..	..	..	..
Sept. 11, 1886	2.50	City of Baton Rouge	Down	....	5½	9	...	....	6	5½	...	....	....	5½	5	....	...	6	7	6½	...	5½	5½	5	5½	....	12	..	..
Sept. 14, 1886	2.10	City of Cairo	Down	....	5	...	....	6	...	6	....	...	....	5	7	6	...	6	..	...	....	5½	5	5	5½	....	8	..	..
Sept. 15, 1886	2.00	City of Saint Louis	Down	...	5½	...	....	6	6½	6	....	....	...	5¼	6	5½	...	..	5	....	....	6	6	5	6	....	..	..	..
Sept. 18, 1886	2.40	Belle Memphis	Down	...	5½	9	....	..	7	6	8	..	...	5	7	7	8	6	6	12	6	6	5	5	6	....	..	..	..
Sept. 19, 1886	2.50	Annie P. Silver	Down	..	6	...	...	6½	6	6	8	...	.	5½	6	5½	7	5½	6½	10½	6½	5½	6	6	6	....	..	..	..
Sept. 22, 1886	2.60	Arkansas City	Down	.	6½	....	....	7	7	5½	9	...	...	5¼	7	6	....	5½	7	8	....	...	6	7	5½	....	12	..	..
Sept. 25, 1886	2.40	D. R. Powell	Down	6	6	....	...	6	6	6	7½	...	...	5	7	5½	...	5	6½	....	6	6	6½	6	5	....	..	..	..
Oct. 2, 1886	3.20	Belle Memphis	Down	....	6½	....	...	....	.	9	9	...	10½	...	...	..	...	..	..	....	...	...	..	...	..	....	..	..	..
Oct. 5, 1886	3.40	City of Baton Rouge	Down	....	6	...	....	7	7	5½	...	....	...	5½	...	....	...	8	8	....	....	....	6	8	6½	....	..	..	..
Oct. 21, 1886	2.80	Gen. Gillmore	....	8	7	10½	...	7	....	8	...	8½	..	5½	6	6	6½	6	7½	6½	6	6	6	8	5½	....	6	6½	8½
Oct. 25, 1886	2.60	City of Baton Rouge	Down	7	....	...	....	8	8	8	....	....	6½	....	...	....	....	7	8	..	....	6	9	8	6	8	..	..	..
Oct. 26, 1886	2.70	Gen. Gillmore	....	8	6½	10½	....	8	....	8	....	....	....	5½	6	6	7	6	7	7	6	5½	6	8	5½	....	7	..	..

APPENDIX E.—*Depth of water (in feet) upon bars between Saint Louis and Cairo*—Continued.

Date.	Stage above stand-ard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Twin Hollows.	Board's Island (foot).	Jim Smith's.	Sulphur Springs.	Herculaneum, Swashen.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Fish Bend.	Fort Chartres.	Turkey Island.
	Feet.																	
Nov. 1, 1886	3.60	Gen. Gillmore		10½	11	10½	9½	9½	10½									
Nov. 2, 1886	3.60	Belle Memphis	Down												6½			8
Nov. 2, 1886	3.60	Gen. Gillmore		10½	12	10½	9½	9½	10½									
Nov. 3, 1886	3.40	do		10½	12	9½	9	9½	10½									
Nov. 4, 1886	3.20	do		9½	11	9½	9	9	9½									
Nov. 8, 1886	2.40	do		9½	11	9	8½	9	9½	9								
Nov. 9, 1886	2.20	do		9½	11	9½	8½	9	9½									
Nov. 10, 1886	2.20	do		9	10½	9	8½	9	9½									
Nov. 11, 1886	2.10	do		9½	10½	9	8	9	9	9								
Nov. 12, 1886	2.10	do		9½	10½	9	8	9	9½									
Nov. 13, 1886	2.20	do		9½	10½	9½	8	9½	9½									
Nov. 15, 1886	2.10	do		9½	10½	9½	8	9½	9									
Nov. 16, 1886	1.90	do		9½	10½	9	8	9	9									
Nov. 19, 1886	1.80	do		9	10½	9	8	9½	9½									
Nov. 20, 1886	1.50	do		9	10½	9	8	9½	9½									
Nov. 27, 1886	1.30	do		9	10½	10½	8	9	9	9								
Dec. 1, 1886	−0.10	do		8	9	8	7	7	8	7								
Dec. 8, 1886	3.30	do					3½	4	5	3½								
Dec. 23, 1886	−0.10	Wyoming	Down			8½			6½	7½			5		8			5½
Feb. 1, 1887	2.80	City of Vicksburg	Down								12	9						
Feb. 2, 1887	2.40	City of Saint Louis	Down		12	13½	12											
Feb. 8, 1887	3.40	Belle Memphis	Down				10½	12		9	12		9	10½	8½		9	
Feb. 9, 1887	4.00	Gen. Gillmore		12	14	12	10½	12	15	10½								
Feb. 11, 1887	9.70	Annie P. Silver	Down										8½		9½			
Mar. 4, 1887	9.09	City of New Orleans	Down										12					
Mar. 8, 1887	12.80	City of Natchez	Down				15								13½			
Mar. 11, 1887	12.20	City of Saint Louis	Down				15						15					
Mar. 12, 1887	12.50	Gen. Gillmore		18		21	18½	15		16½	15	16½		13½	12	16½	18	16½
Mar. 13, 1887	12.50	Arkansas City	Down		16½		15					15	15	15	15	18		
Mar. 18, 1887	15.80	W. S. Hays	Down				15							12	15			
Mar. 19, 1887	16.00	Gen. Gillmore		21	21	22	19½	18		18								
Mar. 20, 1887	15.80	City New Orleans	Down										18					
Mar. 24, 1887	14.70	City Baton Rouge	Down										9					
Mar. 24, 1887	14.70	Gen. Gillmore		20	21	21	18	18		16½	15	18		13½	13½	18	21	20
Mar. 27, 1887	12.80	City of Saint Louis	Down				15						12				10½	

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Saint Genevieve Bend.	Kaskaskia Island. Fairy Island.	Mary River.	Mansoce.	Liberty Island.	Jones's Point.	Apple Creek.	Crawford's.	Moccasin Springs.	Kinney Point.	Devil's Island.	Beaver Dam Rock.	Jacket Pattern.	Goose Island.	Hacker's Bend.	Saladin Towhead.	Thompson's.	Greenleaf's.	Abel's Towhead.	Greenfield's.
	Feet.																						
Nov. 2, 1886	3.60	Belle Memphis	Down			7		8	8	6				8	8		6	7½	8	6	10½		
Dec. 17, 1886	−0.90	D. R. Powell	Down													6	5	8	7	6		9	
Dec. 23, 1886	−0.10	Wyoming	Down	6		5½		8	10½	7	7	7	8	7½		6	6	7½					
Feb. 1, 1887	2.80	City of Vicksburg	Down	12																			
Feb. 8, 1887	3.40	Belle Memphis	Down	10½		9	10½	9	12	9½	12	12		12									
Feb. 11, 1887	9.70	Annie P. Silver	Down	9				13½		12½													
Feb. 14, 1887	13.70	City New Orleans	Down		15																		
Mar. 4, 1887	9.09	City New Orleans	Down	15		10½				12													
Mar. 8, 1887	12.50	City Natchez	Down										10½										
Mar. 11, 1887	12.20	City Saint Louis	Down							15													
Mar. 12, 1887	12.50	Gen. Gillmore											13½										
Mar. 12, 1887	12.50	Arkansas City	Down				15						12										
Mar. 18, 1887	15.80	W. S. Hays	Down			13½				12			13½										
Mar. 24, 1887	14.70	City Baton Rouge	Down										9½	15									13½
Mar. 24, 1887	14.70	Gen. Gillmore		15																			
Mar. 27, 1887	12.80	City of Saint Louis	Down			9	18	15		16½			12	12	24	9½	10½	13½		18	15		

APPENDIX E—*Depth of water, in feet, upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Turin Hollows.	Beard's Island (foot).	Sulphur Springs.	Herculaneum, Swashen.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Fish Bend.	Fort Chartres.	Turkey Island.	Little Rock.	Sainte Genevieve.	Sainte Genevieve Bend.	Kaskaskia Cut-off.
	Feet.																				
Apr. 1, 1887	16.40	Gen. Gillmore		20	20	21	19½	19	15	15	18		14	15	20	21	22			15	
Apr. 4, 1887	16.00	W. S. Hays	Down				16½						10½			18					
Apr. 6, 1887	13.50	Arkansas City	Down				15				15		15								
Apr. 8, 1887	12.00	Gen. Gillmore		18	18	19	16½	16½	13½	12	15		12	12		19½	15			12	
Apr. 8, 1887	12.00	City New Orleans	Down				13½			21		12				13½					
Apr. 11, 1887	11.50	City Baton Rouge	Down				13½						12	13½						13½	
Apr. 13, 1887	10.60	Belle Memphis	Down				10½		15	15	16½		6½							12	
Apr. 13, 1887	10.60	City St. Louis	Down	16½			10½						9	9½		15					
Apr. 14, 1887	9.90	City Providence	Down				10½						9½	10½		13½				12	
Apr. 15, 1887	9.60	Gen. Gillmore		16½	16½	16½	10½	12	12	10½	12		9	10½							
Apr. 17, 1887	8.90	Arkansas City	Down				9						8							9	
Apr. 17, 1887	8.90	Annie P. Silver	Down				10½						6	9½			15			7	
Apr. 20, 1887	10.90	City of Vicksburg	Down				10½						10½	12		15				10½	
Apr. 21, 1887	11.10	Gen. Gillmore		16½	16½	18	10½	13½	13	12	13½		9½	10½	18	19½	18			13½	
Apr. 21, 1887	11.10	W. S. Hays	Down			16½	10½	18		15		9		12		15	10½				
Apr. 26, 1887	13.70	City New Orleans	Down				16½					16½				10½					
Apr. 28, 1887	13.00	Gen. Gillmore		16½	16½	17	10½	12	12	10½			9½	10½							
Apr. 29, 1887	12.90	do					10½	12	12	10½			10½	13½		18	14			10½	
Apr. 29, 1887	12.90	Arkansas City	Down				10½				12		12	15						12	
Apr. 29, 1887	12.90	City Baton Rouge	Down										12								
May 2, 1887	12.90	City St. Louis	Down				15					13½								13½	
May 2, 1887	12.90	City Vicksburg	Down	18			13	18			16½	12								15	
May 6, 1887	14.20	Gen. Gillmore		18	19	19	12	13½	13½	12											
May 9, 1887	13.30	do		17	18	19½	10½	12	12	10½											
May 9, 1887	13.30	W. S. Hays	Down										16½								
May 11, 1887	12.50	Arkansas City	Down				12	16½	12	12	12		12								
May 12, 1887	12.10	City Vicksburg	Down										12	15						12	
May 12, 1887	12.10	City New Orleans	Down	18			10½			15	9	13½								13½	
May 15, 1887	11.40	City Baton Rouge	Down				12	12	12	12	13½		12	12			12			10½	
May 16, 1887	11.90	Gen. Gillmore		17	17	18	12	13½	13½	12											
May 16, 1887	11.90	Jay Gould	Down	16½			9½	16½	15	13½	16½		10½	13½				15		10½	
May 18, 1887	12.10	Belle Memphis	Down				12				16½	10½		12					12		
May 18, 1887	12.10	City St. Louis	Down				15					12		15						10½	
May 20, 1887	12.70	City of Providence	Down				13½						13½			15					
May 22, 1881	11.70	Annie P. Silver	Down				10½					10½		12						10½	
May 22, 1887	11.70	Arkansas City	Down				10½	15			15		12							12	
May 25, 1887	10.70	City Vicksburg	Down				9					9								9	
May 26, 1887	10.60	Gen. Gillmore		14	15	15	9½	10½	10½	12											
May 26, 1887	10.10	W. S. Hays	Down				9½	21		13½		9		10½		13½	18			9½	
May 28, 1887	10.70	City New Orleans	Down				9			10½	13½	10½		12						8½	
May 31, 1887	10.70	Gen. Gillmore		13½	14	13½	9½	10½	10½	10½	9½		9	10½	12	10	13½	9½	12	9½	13½

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction up or down.	Kaskaskia Island, Fairy Island.	Mary River.	Allen's.	Liberty Island.	Jones's Point.	Ryan's.	'76 Crossing.	Grand Tower Island.	Apple Creek.	Crawford's.	Moccasin Springs.	Hanging Dog.	Bainbridge.	Kinney Point.	Devil's Island.	Flora Creek.	Jacket Pattern.	Goose Island.	Hacker's Bend.	Saladin.	Thompson's.	Scudder's Towhead.	Greenleaf's.
	Feet.																									
Apr. 1, 1887	16.40	Gen. Gillmore		25	15																					
Apr. 4, 1887	16.00	W. S. Hays	Down		13½						16½						16½	10½		15	15	16½				
Apr. 6, 1887	13.50	Arkansas City	Down								16½							15		15	15					13½
Apr. 8, 1887	12.00	Gen. Gillmore			12																					
Apr. 8, 1887	12.00	City New Orleans	Down		12						13½							10½		13½	13½			13½		21
Apr. 11, 1887	11.50	City Baton Rouge	Down		9	15		18			12		18					9½		12	12	16½	18	16½		16½
Apr. 13, 1887	10.60	Belle Memphis	Down		12			15			12							10½		13½	12	15		12		13½
Apr. 13, 1887	10.60	City Saint Louis	Down		9	15	12	16½			12							9		9	8½	12		15		15
Apr. 14, 1887	9.90	City of Providence	Down		9						9							6½		9½	8	10½		10½		10½
Apr. 17, 1887	8.90	Arkansas City	Down		9		10½				9½							8		10½	12	13½		12		
Apr. 17, 1887	8.90	Annie P. Silver	Down		9	9	9	13½			10½							8		10½	7	12	13½	9		15
Apr. 20, 1887	10.90	City of Vicksburg	Down		10½		12	13½			10¾							9		12	9	12	16½	12		15
Apr. 21, 1887	11.10	Gen. Gillmore			10½		15																			
Apr. 21, 1887	11.10	W. S. Hays	Down		12								16½					9		13½		15		10½		15
Apr. 26, 1887	13.70	City New Orleans	Down																		12					
Apr. 29, 1887	12.90	Gen. Gillmore			10½																					
Apr. 29, 1887	12.90	Arkansas City	Down		10½	15					15	13½														
Apr. 29, 1887	12.90	City Baton Rouge	Down															12			16½					
May 2, 1887	12.90	City Saint Louis	Down		13½													12								
May 2, 1887	12.90	City Vicksburg	Down		12							15						12								
May 9, 1887	13.30	W. S. Hays	Down									10½						12								
May 11, 1887	12.50	Arkansas City	Down		10½	15		12										10½			12	12				15
May 12, 1887	12.10	City Vicksburg	Down		10½		21		18			15			21			10½		15	15	15				
May 12, 1887	12.10	City New Orleans	Down		13½				15		13½	12						10½		13½	15	15				
May 15, 1887	11.40	City Baton Rouge	Down		12	15			13½			12			18			10½		12	12	13½		15		16½
May 16, 1887	11.90	Jay Gould	Down		12	13½	13½		15	16½		13½	12				10½			12	12	12	12	12		16
May 18, 1887	12.10	Belle Memphis	Down		13½							13½						9½			10½					
May 18, 1887	12.10	City Saint Louis	Down		12													9½	16½		13½	13½				
May 20, 1887	12.70	City Providence	Down														12									
May 22, 1887	11.70	Annie P. Silver	Down		13½				10½			9½					9½			12	10½	13½				
May 22, 1887	11.70	Arkansas City	Down		12	13½											9½				13½	13½		12		13½
May 25, 1887	10.70	City Vicksburg	Down		12	13½	13½		12			8½					9				13½	13½	13½	12		16½
May 26, 1887	10.60	W. S. Hays	Down		9		13½					9½		16½	21	16½	9½	9½		12	12		12	9½		13½
May 28, 1887	10.70	City New Orleans	Down		10½	10½	13½		13½			10½	10½		13½		9	9		12	12		13½		9	13½

APPENDIX E.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Arsenal Island.	Horsetail.	Carroll's Island.	Twin Hollows.	Beard's Island.	Sulphur Springs.	Herculaneum, Swashon.	Cornice Island.	Selma.	Forest Home.	Perry's Towhead.	Fish Bend.	Brickey's.	Fort Chartres.	Turkey Island.	Little Rock.	Saint Genevieve.	Saint Genevieve Bend.	Kaskaskia Cut-off.	Kaskaskia Island, Fairy Island.	Saline Creek.
	Feet.																							
June 1, 1887	9.60	City of Baton Rouge..	Down	......	....	.....	8½	15	9	10½	13½	....	9	12	....	......	......	12	15	......	9½	....	....	....
June 4, 1887	7.90	General Gillmore.....	....	13	13	12	9	10½	9½	10½	9	....	8	9½	12	......	10½	12	9	9	8	10½	....	....
June 4, 1887	7.90	City of Saint Louis...	Down.	......	....	.....	7½	16½	9	9	10½	....	......	8	....	......	12	12	12	12	8½	....	....	....
June 5, 1887	7.70	City of Vicksburg....	Down.	......	....	.....	8	......	9	10½	12	8	......	7½	....	......	10½	......	....	......	7½	....	....	....
June 6, 1887	7.80	Arkansas City	Down.	......	....	.....	8	......	8	8½	10½	....	9	9½	....	......	......	......	....	......	8½	....	....	....
June 6, 1887	7.80	Jay Gould............	Up....	13½	....	.....	9	12	10½	9	12	....	8	8½	....	9	......	......	13	12	......	....	12	....
June 7, 1887	8.10	City of Cairo	Down.	......	....	....	8½	......	12	10½	12	....	8½	9	....	15	12	......	...	7½	......	....	....	....
June 9, 1887	9.70	Jay Gould............	Down	10½	....	.....	8	......	9	6	12	....	8	8	....	......	9	......	....	......	9	....	....	16½
June 10, 1887	8.60	General Gillmore.....	....	14	14	15	10½	12	10½	12	15	....	9½	10½	....	......	......	......	....	......	9½	....	....	....
June 10, 1887	8.60	Belle Memphis	Down.	9	....	.....	8	10½	9	9	12	8	......	9	....	15	12	......	....	9	......	....	....	....
June 12, 1887	8.60	City of Providence...	Down	......	....	.....	8½	......	......	9	12	....	9	9	....	13½	12	......	....	......	7	....	....	....
June 13, 1887	10.90	General Gillmore.....	....	15	16	16½	10½	15	10½	......	......	....	......	......	....	......	......	......	....	......	......	....	....	...
June 20, 1887	12.50	General Gillmore.....	....	16½	18	17	10½	13½	10½	......	......	....	......	......	....	......	......	......	....	......	......	....	....	....
June 20, 1887	12.50	City New Orleans	Down.	......	....	.....	13½	......	......	......	......	....	......	......	....	......	......	......	....	......	......	....	....	....
June 21, 1887	11.70	Belle Memphis	Down.	......	....	.....	12	......	12	12	......	....	13½	12	....	......	......	......	....	......	12	....	....	....
June 26, 1887	11.60	Jay Gould	Up....	......	....	.....	10½	......	......	12	......	....	9	10½	....	......	......	......	....	......	10½	....	....	9½
June 26, 1887	11.60	City Saint Louis......	Down.	......	....	.....	12	......	10½	......	......	....	11	12	....	......	......	......	....	......	12	....	....	....
June 29, 1887	11.80	City Vicksburg	Down	......	....	.....	8½	......	8½	12	12	....	12	12	....	......	......	......	....	......	12	....	....	....
June 29, 1887	11.50	General Gillmore.....	....	17	18	18	12	14	13½	16½	15	....	12	15	18	......	18	16½	....	16½	13½	....	....	....

APPENDIX E.—*Depth of water (in feet) upon the bars between Saint Louis and Cairo.*—Continued.

Date.	Stage above standard low water by Saint Louis gauge.	Name of steamer furnishing report.	Direction, up or down.	Mary River.	Allen's.	Liberty Island.	Ryan's.	'76 Crossing.	Apple Creek.	Crawford's.	Hanging Dog.	Bainbridge.	Kinney Point.	Devil's Island.	Flora Creek.	Cape Girardeau.	Jacket Pattern.	Goose Island.	Hacker's.	Saladin.	Thompson's.	Scudder's Towhead.	Greenleaf's.	Greenfield's.	Mouth of Ohio.
	Feet.																								
June 1, 1887	9.60	City of Baton Rouge.	Down	9½	12	12	15	16½	8½		13½		8½	10½		15	10½	12	12				13½		
June 4, 1887	7.90	City of Saint Louis	Down.	9	9	12			9		19½		8	9				10½	10½	15	7½				
June 5, 1887	7.70	City of Vicksburg	Down.	9	12	9	13½		8	9	21		7	9			10½	9½	15		7½		9		
June 6, 1887	7.80	Arkansas City	Down.	10½		8			8		12			8			12	10½	10½		8½		9		
June 6, 1887	7.80	Jay Gould	Up	10½	12	10½	12		12	12	12		9	12		15	10½	12½	10½	13½	8½		12	16½	21
June 7, 1887	8.10	City of Cairo	Down.	10½	12	12	13½	13½	8½	9	12		7	9			9½	12	13½	15	7½		10½		
June 9, 1887	9.70	Jay Gould	Down.	8½	10½	9	10½		8½	9	12	12	7½	7½		12	9	9	12	13½	8		9		
June 10, 1887	8.60	Belle Memphis	Down	10½	8½	8	9		8				8								9				
June 12, 1887	8.00	City of Providence	Down.	9					10½		18		8	12			10½	9			8				
June 20, 1887	'12.50	City New Orleans	Down				15		13½	13½			13½	13½	13½						12				
June 21, 1887	11.70	Belle Memphis	Down.	15	12		10½		12				9½	15			13½		13½		10½		15		
June 26, 1887	11.60	Jay Gould	Up	12					12				9½	12				9			9				
June 26, 1887	11.60	City Saint Louis	Down	12	12				12				10½	12			12	12	12		7½				
June 29, 1887	11.80	City Vicksburg	Down						12				8½								8½				
June 29, 1887	11.80	General Gillmore		12		12	13½	16½	13½	14		15	12	16½		13½	12	12	13½	13½	12	13½	13½	14	18

W 3.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The improvement of this stream has consisted in the removal of obstructions to navigation in the shape of leaning timber, snags, stumps, etc., and the construction of low wing-dams to facilitate the passage of boats over the shoals during low water.

The work was begun in 1880, and has been continued, when funds were available, up to the present time.

Work was begun for the fiscal year ending June 30, 1887, on September 6, 1886, and was confined to the removal of snags from the channel and the felling of leaning trees on the bank. The work was continued in the fall until November 17, when the weather became too severe for the removal of snags, and the working party was disbanded, the plant being stored and cared for at Hermann, Mo. The work reached a point about 34 miles above the mouth, removing all the channel obstructions and the leaning timber to this point.

A personal examination of the stream was made on March 20 and 21, 1887, to a point 45 miles above its mouth. The examination showed that the stream was well cleared of obstructions up to the point where last season's work closed, and it was decided to clear the portion of the river from Deer Slough, a point 45 miles above the mouth, to the point where last fall's work ceased. The left-hand chute at Deer Slough was almost entirely closed by snags and drift piles, and the right-hand chute by snags and leaning timber. Active operations were commenced on April 25, 1887, when the river had fallen to a suitable stage, and were continued at Deer Slough until June 4, when the channel had been made practicable for rafts and boats. The work was then continued down-stream until the stage of water became too high to work economically, owing to the high stage of the Missouri River. The outfit was laid up at Fredericksburgh, 9 miles above the mouth, where it is in readiness for the resumption of work at the proper time.

The amount of work done was as follows:

Number of snags removed	738
Number of heavy trees felled	1,150

The river is now in a fairly good navigable condition from its mouth to Deer Slough, a distance of 45 miles. Raftsmen complain of a few snags above Deer Slough, to a point 60 miles above the mouth; these can be removed at a small expense. The work has been of benefit to the navigation of the river, especially to the rafting interests, which are quite large.

COMMERCIAL STATISTICS.

Shipments down the river:	
Wheat, 42,776 bushels, at 65 cents	$27,804.40
Corn, 115 sacks, at $1	115.00
Clover, 51 sacks, at $9	459.00
Walnut lumber, 49,000 feet, at 5 cents	2,450.00
Walnut chair-timber, 2 car-loads	325.00
Miscellaneous produce	824.75
Pine lumber (yellow) in rafts, 1,000,000 feet, at $12 per 1,000	12,000.00
Walnut logs in rafts, 50,000 feet, at $40 per 1,000	2,000.00
Railroad ties in rafts, 454,000, at 33⅓ cents	151,333.33
Total	197,311.48
Shipments up the river:	
General merchandise	5,696.15
Total value of river commerce	203,007.63

This statement shows a decrease in shipments, principally in wheat, of which there was reported last year 178,000 bushels, at 70 cents, with a total value of $124,600, while this year there was but 42,776 bushels, at 65 cents, total value of $27,804.40, the difference in value being $96,796. There has been an increase in the railroad ties to the amount of 119,000 ties, of a value of $39,666.66.

The decrease in the shipment of wheat was due to very low water which prevailed last season, which obliged the farmers to haul their wheat by teams to market.

The steamboats engaged in the river commerce are as follows:

Name.	Draught, light.	Burden.
	Inches.	*Tons.*
Faun	16	70
Vienna	12	70
Royal	12	65

With the amount recommended to be appropriated for the fiscal year ending June 30, 1889, it is proposed to continue the removal of obstructions and to close some of the side chutes, in order to concentrate the water in the main channel of the river.

Money statement.

July 1, 1886, amount available	$929.05
Amount appropriated by act approved August 5, 1886	7,500.00
	8,429.05
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	5,353.44
July 1, 1887, amount available	3,075.61
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts 1866 and 1867.	

W 4.

IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS.

The project for the improvement of this stream has consisted in the removal of obstructions to navigation, such as snags and leaning timber, the dredging of channels through shoal places, and the construction of cross and wing-dams to concentrate the water over the shoal places.

The work done during fiscal year ending June 30, 1887, consisted in the removal of snags, stumps, and leaning timber. A working party was organized, and began work September 16, 1886, working up-stream a distance of 61 miles to a point 3 miles above Tuscumbia, where, on November 16, the work was discontinued on account of severe weather, the tools and appliances stored at Hermann, Mo., and the party disbanded.

The work consisted in the removal of 370 snags and the felling of 878 leaning trees.

The work done has been of much benefit to the rafting and boating interests.

COMMERCIAL STATISTICS.

There were engaged in the Osage River commerce during the year just closed the following steamers, viz.: *General Meade*, *Frederick*, *Aggie*, *D. B. Hurlbut*, *Black Diamond*, and *Dick Clyde*.

It has been impossible thus far to obtain a statement of the commerce of these steamers, except in the case of the *Hurlbut* and *Frederick*, and the data as obtained for them is not all that could be wished.

The commerce of the Osage River may be tabulated as follows:

Shipments down the river:		
1,000,000 railway ties	value	$333,333.33
160,000 feet lumber in oak-log rafts	do	1,280.00
10,000 feet lumber in walnut-log rafts	do	120.00
Estimated value of steam-boat commerce		225,223.20
Total value of down-river commerce		559,956.53
Shipments up the river:		
Estimated value of steamboat commerce		45,960.00
Total value of Osage River commerce		605,916.53

The above estimate of steamer commerce is based upon the assumption that the *General Meade*, *Hurlbut*, *Frederick*, and *Aggie* (assisted by the *Black Diamond* and *Dick Clyde*) carried equal shares of the commerce.

The commerce of the river is about three-fourths in amount and value what it was five years ago.

The railway ties are estimated in round numbers, but the estimate is practically exact.

Of these ties 30,000 were taken out of the river at Warsaw, 470,000 at Bagnell, and 500,000 at or below Osage City, at the mouth of the river.

There were also taken out at Warsaw 60,000 feet of lumber in oak logs and 10,000 feet lumber in walnut logs.

There was no steamboat commerce above Tuscumbia during the year. The *General Meade* made an attempt in March to reach Warsaw, but failed to get far above Tuscumbia on account of lack of water on the river bars. For the past few years the *General Meade* has usually made an annual trip to Warsaw.

The head of steamboat navigation is, for all intents and purposes, Tuscumbia, 60 miles above the mouth.

The tie commerce is about what it was five years ago; the steamboat commerce has decreased, due in part to short crops, and in part to railroad facilities. Branch lines of the Missouri Pacific Railway system terminate at the river at Bagnell and at Warsaw—the first point 70 and the other point 170 miles above the mouth of the river.

With the funds available for the fiscal year ending June 30, 1888, and the appropriation asked for fiscal year ending June 30, 1889, it is proposed to remove snags and other obstructions, and cut the leaning trees, and make some necessary repairs to dams, this being the only work that can be done to advantage upon this stream.

The estimated cost of this improvement was $230,000, but the project upon which it was based has been abandoned.

Money statement.

Amount appropriated by act approved August 5, 1886	$10,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	4,027.89
July 1, 1887, amount available	5,972.11
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submittted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

W 5.

PRELIMINARY EXAMINATION FOR A RESURVEY OF OSAGE RIVER FROM ITS MOUTH TO OSCEOLA, WITH A VIEW TO MOVABLE LOCKS AND DAMS, OR OTHER METHODS OF IMPROVEMENT.

UNITED STATES ENGINEER OFFICE,
Saint Louis, Mo., December 10, 1886.

GENERAL: In accordance with instructions contained in letter dated Office of the Chief of Engineers, United States Army, Washington, D. C., October 28, 1886, directing a preliminary examination for a "resurvey of the Osage River from its mouth to Osceola, with a view to movable locks and dams or other methods of improvement," I have the honor to report as follows:

The information in the possession of this office is sufficient without a resurvey to report on the proper method of improvement to be applied to the Osage River from its mouth to Osceola.

The question to be considered is the improvement of the river by "movable locks and dams or other methods of improvement," and resolves itself into two distinct propositions—first, the improvement by movable locks and dams, and second, the improvement by other methods.

(1) IMPROVEMENT BY MOVABLE LOCKS AND DAMS.

The Osage River from Osceola to its mouth at low water consists of a series of pools connected by shoals. The surface of the pools or lakes are perfectly level, and the entire fall of the river is concentrated on the shoals or rapids. It would appear, therefore, that the best and only method of obtaining low-water navigation would be by a method of either movable or permanent locks and dams, as the river adapts itself naturally to such a method, but at present the demands of commerce do not justify the expense attending such a method of improvement.

Maj. O. H. Ernst, Corps of Engineers, in a report to the Chief of Engineers dated August 22, 1884 (see House Ex. Doc. No. 71, Forty-eighth Congress, second session), reports as follows on this subject:

> By your letter of July 31, 1884, I am directed to report as to whether in my opinion the stream is "worthy of improvement." From the wording of the law and from the fact that the Osage has already been the subject of some minor improvements, I understand the question now to be, Is it worthy of improvement by movable dams? That is, is it worthy at this time of a radical and expensive improvement which will cost several millions of dollars?
>
> The Osage empties into the Missouri River at a point about 140 miles from its mouth. To improve the navigable capacity of the Osage beyond that of the Missouri would be almost, if not quite, useless. The navigable depth of the Missouri at low stage is about 3 feet. An improvement of the Missouri River has been projected, but the amount of time which must elapse before that improvement shall be completed is uncertain. It will probably be many years. But whether many or few it would seem proper to defer the inauguration of any scheme, the usefulness of which is very largely dependent upon the safe navigation of the Missouri, until such safety of navigation is an accomplished fact. The distance from Linn Creek to the mouth of the Osage is about 107 miles. In this distance it passes through or touches five counties, Camden, Morgan, Miller, Cole, and Osage, the last two lying also on the Missouri River. Some

portions of these counties will not be affected by the improvement of the Osage, but it is difficult to say how much the statistics of the entire counties will be used in determining the interests to be benefited. The total area of these counties is about 2,800 square miles. By the census of 1880 (see Compendium of the Tenth Census, pages 39, 40, 1553, 1555, 788, 792, and 738) their total population was 54,542; their total assessed valuation, real and personal, was $9,093,013; their total taxation, State, county, and town, was $175,222; and their total production of cereals, including wheat, corn, oats, rye, barley, and buckwheat, was about 5,000,000 bushels, the total production of the State of Missouri being about 247,000,000 bushels. The geology of these counties is known only in a vague way. They contain deposits of iron, lead, and coal, but the size of the deposits is unknown; those of iron are supposed to be large, and those of coal to be small. There are at present no extensive mining interests.

The total value of the commerce of the Osage River during the fiscal year ending June 30, 1882, was $950,778, of which $565,405 was floated in rafts (see Annual Report Chief of Engineers, 1882, page 1660), and for the year ending June 30, 1883, was $1,043,052, of which $215,790 was floated in rafts (see Annual Report Chief of Engineers, 1883, page 1295). Deducting the rafting interest, which would not be benefited, but which would rather be injured by a slack water improvement, there remains a trade of $385,373 for 1882, and $827,262 for 1883. As near as can be computed from the data at hand, the weight carried in 1882 was 9,416.5 tons, and in 1883 21,967.5 tons. The average charge for freight in 1881 was $2 per ton, and in 1882 $4 per ton. Taking the higher rate, the total freight charges would not exceed $38,000 in 1882, and $88,000 in 1883, or an average of $63,000 for each of the two years.

From these facts it appears that there are no interests at this time, either upon the Osage River itself or upon its banks, which will justify a heavy expenditure in the improvement of the river. There are undeveloped resources which such an improvement would aid to develop, but they are uncertain in amount. The most important results to be expected from a radical improvement can not be attained until after the improvement of the Missouri River. I am accordingly of the opinion that the Osage River, from its mouth to Linn Creek, is not at this time worthy of improvement by movable dams.

The conditions which governed the opinion in the above report have in no manner changed since, and from the same consideration I am of opinion that at this time the Osage River from its mouth to Osceola is not worthy of improvement by movable locks and dams.

(2) IMPROVEMENT BY OTHER METHODS.

The methods heretofore applied in the improvement of the Osage River have, since 1872 consisted in the removal of snags and leaning timber, the building of dikes and training-walls to concentrate and deepen the water over the shoals, and the dredging or scraping of the shoal places. The object of this method has been to give a depth for navigation of 2 feet at low water. Heretofore this method has not accomplished the desired result, although it has resulted in the amelioration of navigation to a certain extent; it is, however, in my opinion the only practical plan to follow at present. The stream is at present unnavigable at extreme low water; the work, however, which has been done has facilitated navigation, and I am of opinion that it may be further continued with benefit. It is not practicable to submit an estimate for the work, as it will consist principally in the removal of constantly recurring obstacles and repair of old, and possibly construction of new, works as required, but an annual appropriation of $5,000 would, in my estimation, be sufficient for several years to meet the present wants of navigation. For the reasons above stated, in my opinion the Osage River, from its mouth to Osceola, is not at present worthy of improvement by movable locks and dams, but in my opinion it is worthy of improvement by other methods—that is, by the method heretofore followed.

A letter of Capt. R. M. Marshall, steamer *Frederick*, in relation to the commerce on the Osage River, is forwarded herewith.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

LETTER OF CAPTAIN R. M. MARSHALL, MASTER OF THE STEAMER FREDERICK.

TUSCUMBIA, MO., *November* 20, 1886.

SIR: I inclose you, as per your request, a statement of the shipments on the Osage River for the past sixteen months. The steamers that have been engaged in the traffic during that time are the *Aggie*, *General Mead*, *Frederick*, and *D. B. Hurlbut;* the *Aggie* handling ties and cord-wood, the other three in the general trade.

The shipments for the fall and spring of 1885–'86 (from which the report is taken) show some decrease from that of 1884–'85, due to a partial failure of the wheat crop for 1885.

Otherwise the business is about the same each year, the general increase being very small, although there has been considerable new land opened up and settled in the last few years, and there will undoubtedly be considerable increase in the shipments within a few years.

Wheat is the chief production for market, the shipments of corn and oats being so small as not to be worth mentioning. The entire shipments of corn for the sixteen months would not exceed 5,000 bushels, and oats even less, although there is a great deal of corn raised and fed to stock, which is then put on the market.

The shipments up the river amount to from 50 to 80 tons per month of general merchandise, not including lumber, salt, or other heavy freight. To this you might add 500,000 feet of pine lumber, 3,000 barrels salt, besides lime, heavy machinery, etc.

The shipments would be greatly increased if the river could be depended on, so that boats could run regularly.

There has been no boating done now since the first of August, on account of low water (there being but 10 inches or a foot of water on some shoals), and it is not likely that navigation will open before next spring.

The shipments in this report are almost entirely from Tuscumbia down, a distance of 60 miles, there being no shipments of any importance above that point, although boats occasionally run as high as Linn Creek and take out freight.

This does not include any ties or wood boated by steamer *Aggie* or ties rafted out of the river, of which there are thousands every year.

Will be pleased to give you any other information you may desire.

Very respectfully,

R. M. MARSHALL,
Master Frederick.

J. W. BEAMAN,
United States Assistant Engineer.

STATEMENT MADE BY CAPTAIN R. M. MARSHALL, MASTER OF THE STEAMER FREDERICK, TO ACCOMPANY HIS LETTER OF NOVEMBER 20, 1886.

The following figures indicate the shipment of grain, etc., to the mouth of Osage River, Missouri and Kansas, from the landings on the river:

Date.	Wheat.	Miscellaneous.	Walnut.	Lumber.	Heads of live stock.
1885.	*Bushels.*		*Feet.*	*Feet.*	*Pounds.*
July	5,000	15,000	18,000		
August	6,000	18,500			200
September	4,500	7,500		20,000	
October	5,000	7,200			150
November	8,800	12,000	6,000		200
December	4,500	11,000			250
1886.					
January*					
February*					
March	6,800	30,000			175
April	18,000	63,000		5,000	250
May	16,000	32,000			
June	17,000	31,000			
Year's total	91,600	229,200	24,000	25,000	1,225
July	4,200	12,000			

* Navigation closed on account of ice.

During August, September, October, and up to date navigation has been closed on account of low water.

River Commission, was barely sufficient to care for the plant and property.

By the act of Congress approved August 5, 1886, $60,000 was appropriated for the fiscal year ending June 30, 1887. The last recommendation, that of the Missouri River Commission, had been for $160,000.

Owing to the small appropriation secured, the lateness of the season when it became available, and the early approach of cold weather in the high latitude where it was necessary to expend it, it was thought best not to attempt any work during 1886.

It was recommended to and approved by the Chief of Engineers to spend all of the appropriation upon that portion of the Missouri River lying between Carroll, Mont., and Fort Benton, Mont., known as the "rocky part." The river here is confined by stable banks, has a great fall, many rapids, and the channel is more or less obstructed by loose bowlders and rocks.

The approved project was to begin at Fort Benton and work down the river, constructing dams of brush and gravel, to contract the channel where too wide; to raise the water on the rapids and reduce the slope; to dredge out the heavier gravel-bars, and to remove projecting rock and loose bowlders.

The plant consisted of one steamer, the *Josephine*, lying at Sioux City, Iowa, a large steam-dredge lying at Fort Benton, Mont., and a number of rough barges, skiffs, bateaux, hoisting engines, quarterboat, and tools, lying at Gallatin Rapids, Montana.

The plant thus scattered along the river, mostly at distant and nearly inaccessible places, had been lying idle for a year and was greatly in need of repair.

The dredge, though new, had been constructed with a very weak A, or derrick frame, dangerous to use. The plant at Gallatin needed a general overhauling and repairing.

The lateness of the season and the continuance of a long and hard winter prevented any thing being done on these plants until May, 1887. These repairs have been carried on under great difficulties, owing to the distance from any supply market for labor, lumber, and other articles of repair. This also added greatly to the expense, men and material having to be transported from Saint Paul, Minneapolis, and Sioux City.

On July 1, 1887, most of the repairs had been completed, and it is expected that all the plant will be ready for use by July 31. The steamer *Josephine* being at Sioux City was in the neighborhood of shops and supplies, and extensive repairs were put on her during the winter and spring. She was put in commission June 1, 1887, and started up the river for Gallatin Rapids, taking on at Bismarck a working party of some forty men, with a large supply of repair material and subsistence. She reached Gallatin June 24, and the working party was put to work getting out rock for riprap of dams and cutting brush for fascines for same.

Up to June 30, therefore, no construction work had been done, though over one-third of the appropriation had been expended in making repairs, in transporting men and material to the field of operations, and in buying an outfit of subsistence supplies and tools.

Much of this heavy expense without adequate return could have been avoided had a suitable appropriation have been available early in the spring of 1886.

As soon as the plant is thoroughly repaired the construction work will be pushed vigorously and continued as long as the season will permit. Winter begins early and it will be necessary to stop early in October so as to get the plant into safe winter harbor. All of the present appropriation will be expended by November 1, except just sufficient to care for the property.

By the ultimate completion of the improvement it is expected to secure a navigable channel of 4½ feet at low water over the river from Fort Benton to Carroll. The works previously completed in this portion of the river have accomplished much good in bettering the channel, but have not done good commensurate with their cost, owing to the desultory way in which appropriations have been made.

The work of the present season can only give temporary relief, as the means available will not permit strong and permanent work.

The river from Carroll to Sioux City is very different in character from that above, flowing as it does between unstable banks and abounding in shifting sand-bars. No recommendation for the improvement of this portion of the river can be made until a thorough survey has been completed whereon to base a well-digested project. The funds at command do not justify such a survey, and furthermore this matter is, I understand, under the jurisdiction of the Missouri River Commission.

Temporary betterment can be afforded by keeping this portion of the river free from snags. As Congress has, heretofore, by its legislation made snagging operations a matter separate from river improvement, this, perhaps, should be the subject of report and recommendation by the engineer officer in charge of snagboats on the Missouri River.

Commerce on the Missouri River, between Sioux City, Iowa, and Fort Benton, Mont., has been steadily falling off year by year as the railroads have reached or paralleled and passed beyond it. The completion of the Manitoba Railroad from Saint Paul to Helena, Mont., via Forts Buford, Assinniboine, and Benton, a matter certain of accomplishment before another navigation season, will completely parallel the river above Fort Buford, and will greatly reduce the present commerce over this section of the river.

The Benton Transportation Company operates the only steamers now running on the upper river, and in anticipation of the completion of the Manitoba road is preparing to withdraw several of its steamers. After that, the navigation interests will be small and confined to a local trade, which for a number of years can not be great, as the bordering country is sparsely settled, and much of it closed against settlement by reservations for the use of Indians.

As far as benefiting any navigation interest, present or prospective, is concerned, I see no use in spending any great amount on improving the Upper Missouri River.

There is another view of the matter, however, that may commend itself as an affair of wise public policy. As long as there is, during the season of navigation, a good permanent channel extending from the Mississippi Valley into the heart of Montana, so long will the public be benefited by lower freight rates on competing railroads. This channel may never be used, but its mere existence, ready for use, will act powerfully as a check on extortionate freight rates.

On this account I recommend for the fiscal year ending June 30, 1889, for the Missouri River, from Sioux City, Iowa, to Fort Benton, Mont., an appropriation of $160,000.

Of this I recommend that $110,000 be devoted to the permanent improvement of the rocky portion of the river from Carroll to Fort Benton under the present project, and $50,000 to the removal of snags from the lower and sandy portion from Carroll to Sioux City. I would also recommend that Congress be asked to specify what proportion of the total appropriation shall be used for snagging, should the amount appropriated be less than that asked for.

This may appear a larger amount than necessary, considering the interests involved, and so it would be were the work to be carried on in the neighborhood of material, labor, and supplies.

The work, owing to its isolated situation, in question must necessarily be very expensive. Fuel is very scarce and high in price, and natural material, as brush and stone, is at many places difficult and expensive to obtain.

Freight rates are high, and the distance over which supplies must be carried are very great.

I transmit herewith, marked A, B, and C, papers in reference to the commerce on the Upper Missouri River for 1886 and to July 1, 1887.

Money statement.

July 1, 1886, amount available	$1,091.36	
Amount appropriated by act approved August 5, 1886	60,000.00	
		$61,091.36
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	23,790.60	
July 1, 1887, outstanding liabilities	5,571.89	
		29,362.49
July 1, 1887, amount available		31,728.87
Amount (estimated) required for completion of existing project,* above Carroll		250,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1889		160,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

A.

BENTON TRANSPORTATION COMPANY,
MISSOURI RIVER STEAMERS,
Bismarck, Dak., July 20, 1887.

DEAR SIR: I herewith inclose you statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, and between Fort Benton, Mont., and Bismarck during the year 1886; also, from 1st of April to 1st of July during season of 1887. Of course the 1887 statement does not show the wool business, shipments of which are usually made after July 1. Wool shipments this year promise to be heavier than ever before; will amount to about 5,000 bales, value about $300,000.

Yours, truly,

I. P. BAKER,
General Superintendent.

Capt. C. B. SEARS,
United States Engineers.

---

* No project for river below Carroll except snagging.

B.

Statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, Dakota, and between Fort Benton, Mont., and Bismarck, Dak., 1886.

ABOVE BISMARCK.

Trips up, 23:	
General merchandise carried, 5,750 tons	$1,500,000
Trips down, 23:	
Sacks wool (3,800), 1,064,000 pounds	$234,080
Hides, peltries, furs, and merchandise, 1,000,000 pounds	$50,000
Grain, 600,000 pounds	$6,000
Passengers carried	400

BELOW BISMARCK.

Trips, 20:	
General merchandise carried, 5,000 tons	$287,000
Passengers carried	1,500

C.

Statement of business transacted on the Missouri River between Sioux City, Iowa, and Bismarck, Dakota, and between Fort Benton, Mont., and Bismarck, Dak., to July 1, 1887.

ABOVE BISMARCK.

Trips up, 25:	$2,300,000
General merchandise carried, 6,875 tons	
Down-stream:	
Wool, hides, furs, and merchandise, 320 tons	
Passengers carried	610

BELOW BISMARCK.

Trips, 10:	
General merchandise, tons carried, 1,600	$144,000
Passengers carried	250

[NOTE.—Much of the up-river tonnage above Bismarck represents railroad material and supplies for the building of the Manitoba Railroad. It is abnormal in quantity and value.—C. B. S.]

X 2.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

Captain James B. Quinn, Corps of Engineers, in charge until September 20, 1886.

The last appropriation made for this work, previous to the one now reported upon, was by act of Congress approved July 5, 1884, and was for $20,000 only. The most of this had been expended by the close of the working season of 1885.

The small balance left was devoted to the care and preservation of the property and plant, and was nearly exhausted by August 5, 1886, when another appropriation was made of $18,750 only, $74,700 having been asked for.

When this became available it was too late in the season to begin work. The plant was stored at a place distant and, in winter, almost inaccessible. Having been lying on the bank of the river through two winters and one summer, it was in need of extensive repairs, which, on account of the location, could be made only with great difficulty and very great expense, considering their nature and the value of the plant.

As the small sum appropriated could readily be spent in two months, it was determined to postpone work until August and September, 1887, after the high water.

A further study of the situation disclosed the fact that it would take over 50 per cent. of the appropriation to repair the plant, buy necessary tools, transport the working party to and from the field of operations, and charter a steamer, leaving less than 50 per cent. available for actual construction work.

It seemed to me not advisable to spend the appropriation and obtain such inadequate results, especially as a good deal of repair work on the dams heretofore built would have to be done.

Again, there is no commerce carried on on this river. No commercial boat has been on the river since the Northern Pacific Railroad reached Glendive, nor is there any likelihood of there being any for several years. There is no through or local trade demanding the use of steamers.

For these reasons, viz, the large percentage of the appropriation necessary to be expended simply to initiate the work, the expensive and unsatisfactory work that could be done with the balance, and the absence of any present or prospective demand for aid by navigation interests, I reported to the Chief of Engineers that it would be neither economical nor advantageous for the Government to expend the small appropriation available, and I recommended:

1. That no construction work on the Yellowstone be undertaken this season.
2. That the present plant be repaired just sufficiently to float it to the mouth of the Yellowstone, where, in the vicinity of Fort Buford, it can be taken care of to better advantage, and where permanent repairs can more readily and more cheaply be made.
3. That the whole matter be reported to Congress for further legislation; that is, for a further appropriation large enough to work to advantage.
4. That the present appropriation be used to thoroughly repair the present plant and buy a good outfit of new plant, suitable for the efficient and economical prosecution of work under a new appropriation.

My letter on this subject is still under consideration by the War Department.

The present approved project is to work down the river from Glendive, repairing existing dams, putting in new ones where necessary to close chutes, thus confining the water to one channel and deepening it on the rapids, and to remove rocks and bowlders.

At certain points heavy gravel-bars exist, requiring the use of a dredge to remove them.

The Yellowstone, for a swift snow-fed river, is an excellent one naturally, and susceptible of radical improvement at a relatively small expense, considering its distance from labor and supply markets. Though not at present navigated, the existence of a good navigable channel will always be a check on high railroad tariffs to competing points on the river.

If Congress deem this a sufficient cause for the continuation of the improvement, $60,000, in addition to the present available balance, can be profitably expended during the fiscal year ending June 30, 1889.

Money statement.

July 1, 1886, amount available	$693.51
Amount appropriated by act approved August 5, 1886	18,750.00
	19,443.51
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,912.68
July 1, 1887, amount available	16,530.83
Amount (estimated) required for completion of existing project	106,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

X 3.

PRELIMINARY EXAMINATION OF JAMES (DAKOTA) RIVER, DAKOTA TERRITORY.

UNITED STATES ENGINEER OFFICE,
Bismarck, Dak., November 30, 1886.

SIR: I have the honor to submit the following report and accompanying tracing relating to the preliminary examination of James River, Dakota Territory, made in pursuance of your printed circular letter of October 28, 1886, and in accordance with section 6 of the river and harbor act of August 5, 1886.

Under the name of Dakota River, an examination of the James River was made by direction of Maj. F. U. Farquhar, Corps of Engineers, in October and November, 1874.

* * * * * * *

This report was printed in House Ex. Doc. No. 75, part 1, Forty-third Congress, second session.

* * * * * * *

As it fully described the physical features of the James River and the bordering country, I have confined my attention to an inspection of the river at the most important points between Jamestown, on the Northern Pacific Railroad, and the mouth of the river, and to a study of the commercial needs of the valley, of its present transportation facilities, and of public sentiment with reference to Government aid towards the improvement of the navigation of the James.

I began my inquiry by addressing a letter to the Hon. O. S. Gifford, Territorial Delegate to Congress. He could give me no information as to any parties residing in the valley who were anxious for river improvement, except as to one man at Columbia, who owned a flouring mill and thought a higher and stronger dam to raise the water in Lake Columbia (Tehanchicahah) would improve his water-power, as it undoubtedly would.

At Columbia I ascertained that the last Territorial legislature had petitioned Congress to appropriate $25,000 for the improvement of the James River above Columbia. This was evidently in the interest of the milling people, to give them increased water-power.

* * * * * * *

I also ascertained that some years ago, about 1880 or 1881, a small stern-wheel steamboat had been taken by rail, in sections, to Jamestown, Dak., and there put together, and from there sent down the James to Columbia at high water; that it had made a few trips for several seasons from Columbia, some 60 miles up the river, and that it had been abandoned as soon as railroads were built into this portion of the valley. I saw it lying on the bank at Columbia, dismantled and wrecked. It was about 120 feet long, some 20 feet beam, and probably drew 24 inches when loaded.

As far as I could learn this was the only boat that ever navigated any portion of the James. There may have been, possibly, a boat or two a few miles up the river from the mouth, at high water some years ago, when there were more boats navigating the upper Missouri, but I could not ascertain that such had been the fact.

* * * * * * *

Within the past five years this valley has increased very rapidly in population, in cultivated farms, and in thriving towns and villages, all due to the rapid and extensive development of the competing lines of railroads with which the valley is fairly "gridironed."

This increment of prosperity is still going on at an undiminished rate. The people are law-abiding, industrious, enterprising, and intelligent, and the valley bids fairly to be soon the site of a large and wealthy community.

The following will show the commercial importance of the valley. The latest reliable information is to October 1885, and is compiled from the 1885 report of Hon. Gilbert A. Pierce, Territorial governor, to include the half of Stutsman County south of the Northern Pacific Railroad, and all the counties bordering on or through which the James River flows down to the mouth.

Population, 1885, 75,000; now, about 100,000.

Improved farms	acres	1,216,000
Value of farms		$31,191,000
Value of implements and machinery		$2,561,000
Value of live stock		$6,029,000
Value of farm produce		$6,088,000
Bushels of grain produced in 1885		12,519,000
Bushels of flaxseed		590,000
Bushels of potatoes		622,000
Pounds of butter		1,619,000
Tons of hay		198,000

The grain consisted of wheat, over 6,000,000 bushels; of oats, over 4,000,000; of corn, nearly 2,000,000; and of barley, rye, and buckwheat. There were also considerable productions of eggs, cheese wool, etc.

The above statistics for 1885 can with safety, for 1886, be increased 20 per cent.

Of the imports no reliable statistics could be gathered, but they consist principally of coal, lumber, farming implements, and general merchandise.

The great commercial needs of the valley are lower import rates on fuel and lumber and lower export rates on grain. Fuel is now brought from Chicago, Duluth, and Superior City. The present railroad rates are $5 per ton for hard coal, and $4.50 per ton for soft coal from Chicago to the center of the valley. Assuming the best possible slack-water navigation for the James, giving 4 feet, fuel would have to be brought up the Missouri from its mouth, a distance to the center of the James River valley of over 1,500 miles. It would be up stream navigation, and on account of the crookedness and narrowness of the James, the tows would have to be small, as also the cargoes. Freight on coal from Louisville to Memphis, in large tows and cargoes and all down-stream navigation, a distance of only 500 miles, adds $1.50 per ton to the price of coal. It is fair to assume, considering the all up-stream navigation, the strong currents of the Missouri, the crooked channels of both rivers, the bad sand-bars, and the consequent high rates of insurance, that coal could not be put down at the center of the valley for a less rate than now charged by the railroads.

The export rates on grain from the center of the valley to Chicago and Milwaukee run from 28 cents to 30 cents per 100 pounds, and to Minneapolis and Saint Paul 23 cents per 100 pound. With the navigation aforesaid on the James, grain might be delivered at Saint Louis at somewhat cheaper rates than the above, but the bulk would still go by rail from the James River Valley, as it does to-day from Saint Louis, rather than via the river and Gulf; but, nevertheless, during the very short navigation season railroad rates would be materially lowered to bid for the entire transportation of the crops.

This is the one and only advantage to be derived from a navigable condition of the James. The actual amount of benefit, however, would be a very indeterminate quantity, and certainly not commensurate with the great cost of improvement were any practicable.

The accompanying tracing* will show how abundantly the valley is now provided with transportation facilities, and how it is dotted over with prosperous towns and villages.

Ten railroads now come into the valley, at least as far as to the James River, and at right angles to it, and parallel to the current of import and export trade. Another branch, at a right angle, is within 30 miles of the river.

There is a continuous line of railroad parallel and near to the river throughout its length, and for the greater portion of this distance there are two parallel roads, while over a distance of 70 miles there are three parallel roads, * * * all rivals, and each seeking every year, strenuously, to increase its mileage in the valley and the volume of its business. With this condition of affairs the present rates can not long be maintained even by "pooling." So much for the commercial needs and transportation facilities of the valley.

Next, as to the feasibility of the improvement of the James River.

In my opinion no general through improvement, giving access to the Missouri River, is practicable. It is barely possible that with an extraordinary and totally unreasonable expenditure a slackwater navigation of locks and dams might be secured, though the engineering difficulties at the mouth are almost insurmountable. Assistant Ainsworth, in his report to Major Farquhar, says of the mouth of the James: "The Missouri at the mouth of the Dakota (James) was in good navigable stage, but the appearance of the latter was anything but promising, as its mouth had been sealed up by the deposits of the Missouri while in flood. The river here was from 75 to 100 feet wide and from 3 to 8 inches in depth, with considerable fall over a bed of mud 3 feet deep and of the consistency of mortar." I found in November, 1886, still less water and considerably more mud. If it were possible to build a lock here, dredging in the tail bay would have to be kept up continuously to keep open the entrance.

The James is probably one of the most crooked rivers in the world. It is over 1,000 miles in length in an air line of 300 miles. This fact would add immensely in cost to any scheme of slackwater navigation.

---

* Omitted.

Assuming the engineering difficulties overcome, there is a very strong and reasonable doubt whether there would be enough water to supply even a limited number of lockages per day. Assuming sufficient water, the canal could be used only six months in the year. From the middle of October to the middle of April it would be liable to be frozen.

Another item of expense would be the actual damages to be paid by the United States to corporations, counties, and riparian owners for obliging them to put draws in bridges and to remove dams, or for lands overflowed on account of new dams. There are now across the James some twenty-one railroad bridges and about one hundred common road bridges, all founded on mud-sill trestles or on piles. There are also about twelve mill-dams.

* * * * * * *

Assuming all the above difficulties as overcome, I think neither the people of the valley in particular, nor of the country in general, would derive any practicable benefit from the improvement, for, as I said before, the channel of commerce is east and west, while the channel of the James is north and south, and a parallelism of orientation can never obtain. The James can not compete with the extensive system of railroads invading the valley in every direction. It will always be a valuable stream to the riparian residents as a source of water supply for domestic and sanitary purposes and for affording water-power for mills and factories, but for no other purpose will it be valuable.

In a number of places, extending in reaches of from 10 to 50 miles, the slope of the surface is very slight and the water could be backed up by dams of low relief and comparative small cost, so as to afford a navigable channel of 3½ to 4 feet over these reaches, but these would lie wholly within the Territory and could have no navigable connection with each other or with any other Territory or State, and probably, therefore, could not legitimately be the subject of legislation by Congress; or, if so, the interests to be subserved would be too insignificant to warrant the expenditure.

In conclusion, I would say that I fully agree with Major Farquhar, "that the river" (the James) "can not be made navigable by the ordinary means of improving the natural channel, for the reasons that there is not a sufficiency of water and that the river is too tortuous."

In my opinion the James River in Dakota Territory is *not* "worthy of improvement," and I would recommend that no survey be made.

I remain, general, very respectfully, your obedient servant,

CLINTON B. SEARS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX Y.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

REPORT OF CAPT. E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENT.

1. Mississippi River between the Des Moines Rapids and the mouth of the Illinois River.

EXAMINATION.

2. Bars in Hamburg Bay, Illinois.

Y 1.

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

United States Engineer Office,
Quincy, Ill., July 9, 1887.

Sir: I have the honor to render the following report of operations for the fiscal year ending June 30, 1887, in the improvement of the Mississippi River between the Des Moines Rapids and the mouth of the Illinois River:

During the working season of 1886 operations under the appropriation of 1886 were confined to dredging the bar at the mouth of Hamburg Bay.

Hamburg Bay is about 68 miles below Quincy, or by the channel about 3 miles further. It is about 90 miles above Saint Louis by the channel. An agricultural region, having no railroad through it, finds an outlet through the landings on the bay and lower down. With a bar whose crest was about low-water datum just at the mouth, navigation was prohibited at low stages of the river.

When dredging began, on October 12, the dredge and fleet could not cross the bar. Work began by making a first cut by casting. The cut was shallow, only to 4 feet below low water and about 450 feet long. Sufficient way room being thus secured, the subsequent dredgings were removed by the launch *Iris*, in attendance, and dumped in a small chute to the west.

Subsequently 5¼ long cuts were made, giving a whole area dredged about 1,000 feet in length by 130 in width. Great care was taken during the progress of the work to so regulate the width and depth of the cuts as to maintain, if possible, for a while at least, a depth of 6 feet at low water; a task that required constant attention, for the very soft material was apt to slide in and fill up the ground previously worked.

Previous to beginning the work steamboats could not enter the bay whenever the river fell below a 3½-foot or 4-foot stage. Thus for some time prior to October 12 no steamer had entered the bay. This compelled shippers to haul all goods some 3 miles down the river to Mozier's. Soon after the first cut was made the *Dora* began (on October 24) making her regular tri-weekly trips up the bay, and taking large quantities of apples and produce to the Saint Louis market.

On November 17 the steamer *Saint Paul*, the largest steamer on this river, with the steamer *Flying Eagle* in tow on one side and a large model barge on the other, entered the bay, having backed down the "cut-off," and passing up the dredged channel without difficulty, took up winter quarters in the bay. On the following day the *Gem City*, a side-wheel steamer of almost equal size, entered also for the same purpose. It is noteworthy that these results should follow so closely the work done, without which work neither boat could have entered. The total amount dredged in 1886 was 26,925 cubic yards.

Work was resumed in March, 1887, and ceased at the end of April. A channel has been dredged to not less than 6 feet depth at low water through the bar at the mouth of the bay, the least width being 240 feet, and the lower eastern end or point was widened to a total of 410 feet, giving a good flare to the entrance for boats coming up the river.

Total material dredged in April, 1887, 16,593½ cubic yards, which, added to that dredged last fall, makes a total of 43,518 cubic yards removed from this bar.

I believe the channel will be ample now in width and depth, and that the probabilities are that it will be permanent.

At the close of the work the fleet was transferred to Oyster Island, opposite La Grange, to construct a graveling dam there in connection with other works. The inspector, Mr. J. C. McEtherne, was transferred in April to the Turner's Island work, and I myself took charge during the rest of the work.

Under authority work was begun at Cap Au Gris as early in the spring as the fleet could be got in readiness. Assistant Engineer O. N. Chaffee was placed in charge, and the *Coal Bluff* took barges and quarter-boats from Quincy on April 6. The steamer unfortunately struck a snag on the 7th, knocking a hole in her bottom. By the greatest of luck she was saved by beaching on a flat bar near by; was then repaired temporarily, sent to Saint Louis, docked, and returned to work on the 11th. Since then operations have been conducted with great vigor, and no delay or accident has occurred. Rock has been procured under contract from the Grafton Quarry Company, at Grafton, at 40 cents per cubic yard on the barge. The tow up-stream, 22 miles, is long, and nothing but the low price of rock would justify it. Excepting for some two weeks in June, when we were obliged to get rock from the quarry at Dixon's, the rock has been furnished as rapidly as desired.

A variation was made this year in the mode of supplying the fleet: subsistence, rope, lath yarn, and steam-boat stores are furnished under contract for the season; the prices are slightly in excess of those for last year, but the relief to the disbursing officer is very great.

The first work done was a connecting dam, about 620 feet long, between islands 500 and 501. This was completed by April 27, except that additional rock was put on subsequently as the water fell and showed the need of filling certain holes.

There have been placed in this dam—

Rock	cubic yards..	4,343
Brush	do....	2,888
Total material		7,231

Work began April 27 on the protection of Island 499, and was carried on, as opportunities permitted, in connection with other parts of the work. This was not completed until some time in June, when 2,595 linear feet were reported as the total length, and—

Rock	cubic yards..	4,499
Brush	do....	2,252
Total material		6,751

The island is a growth of recent years, and has large sand deposits above and below it. It is hoped the work done on it will make it permanent and hold the river deposits near it in their present places. Should these sands move down into the next reach, a good stretch of river might become difficult of navigation.

Island 500 was graded in May, and during that month and June 1,591 linear feet of shore protection was placed, using—

Rock	cubic yards..	3,185
Brush	do....	1,355
Total material		4,540

There is needed yet some rock to finish this work. The head of this island was protected in 1882, and this work is a continuation.

It became evident in May that to make the plan of work at this vicinity complete a large concave bend on the main shore at Cap Au Gris should be protected also. Authority having been obtained for this, work was begun during the last week in May, and up to the last week in June 1,986 linear feet had been worked upon, some being as yet unfinished.

Rock	cubic yards..	3,853
Brush	do....	2,588
Total material placed in this work		6,441

There will be required almost as much more material to complete this part of the work. This shore had been cutting badly and sending its material directly into the river next below, and a bar on the opposite shore has recently appeared where formerly was good water. It is hoped when our work is done no material will be likely to pass from above down for some 7 miles of river. The closing of the gap between islands 500 and 501 set the current flowing so strongly around the head of Island 500 to the east as to begin to cut out this channel very materially. A gap about 450 feet wide and from 8 to 13 feet in depth, with a strong current in it, existed between the head of the island and the large bar lying to the north and east. This gap was to be closed in order to build the main dam, as proposed, from Island 500 to the Illinois shore. Other work was suspended to allow of this being done expeditiously the last week in June, and the sill was laid that week.

Rock	cubic yards..	402
Brush	do....	355
Total material placed that week in that work		757

In all, the *Coal Bluff* and plant placed—

Rock	cubic yards	16,282
Brush	do	9,438
Total material this spring		25,720

Assistant Engineer O. N. Chaffee remained in charge until June 30. He has resigned his position, and the service loses an active, efficient, and energetic man.

CONTRACT WORK.

Proposals were opened October 24, 1886, for repairs to Gilbert's Island Dam, Cincinnati Landing Chute wing-dams and their shore protections, and the abstract is here given:

Abstract of proposals for furnishing material and doing the work of repairs to Gilbert's Island Dam, Denmark Island Dam, Cincinnati Landing Chute wing-dams and their shore protections received in response to advertisement of September 24, 1886.

No.	Name and residence of bidder.	9,000 cubic yards rock.		6,000 cubic yards brush.		Aggregate.
		Price per cubic yard.	Amount.	Price per cubic yard.	Amount.	
1	A. J. Whitney, Sandusky, Iowa	$1.98	$17,820	$0.98	$5,880	$23,700
2	Patterson Bros., Keokuk, Iowa	1.50	13,500	.80	4,800	18,300
3	H. S. Brown, Quincy, Ill.*	1.35	12,150	.70	4,200	16,350

* Accepted and contract entered into.

Work began under this contract in the last week of April, 1887. The main Gilbert's Island dam was raised and repaired to an average level of 5 feet above low water.

Rock	cubic yards	1,123.15
Brush	do	922.38
Total material used		2,045.53

In Cincinnati Chute the lower wing-dam was repaired.

Rock	cubic yards	1,719.30
Brush	do	828.41
Total material used		2,547.71

Then the shore was protected where cutting, on the Illinois shore at various places a total of 2,675 linear feet being repaired and built.

Rock	cubic yards	2,068.33
Brush	do	1,640.30
Total		3,708.63

Repairs to the second wing-dam in the chute amount to—

Rock	cubic yards	1,352.13
Brush	do	798.40
Total material		2,150.53

The contractor has earned $6,324.71, the total amount of contract being $16,350.

Mr. A. J. Stibolt was inspector until June 28, and since then Mr. J. E. Blakemore.

TURNER'S ISLAND WORK.

Under advertisement dated January 15, 1887, bids were opened February 15, 1887, for certain dams, wing-dams, and shore protections at and near Turner's Island.

The abstract of proposals is as follows:

No.	Name and residence of bidders.	12,000 cubic yards brush.	Amount.	21,000 cubic yards rock.	Amount.
		Per cu. yd.		*Per cu. yd.*	
1	Patterson Bros., Keokuk, Iowa	$0.74	$8,880	$1.49	*$31,290
2	A. J. Whitney, Le Clair, Iowa	.75	9,000	1.80	†38,600
3	Jacob Richtman, Fountain City, Wis	.80	9,600	1.75	36,750

*Accepted. † Also for small stone and gravel, 75 cents per yard.

Work began on the 9th of April and has been pushed vigorously since that time until the last few weeks, when a scarcity of labor limited the results. A protection 1,500 feet in length and 35 feet wide was carried in a curvilinear direction around a willow patch on the sand-bar at the head of Turner's Island which it was desired to convert into an island. This consumed—

Rock	cubic yards	3,385.23
Brush	do	2,200.00
Total material		5,585.23

Work on the main dam, 2,015 feet long, connecting Turner's Island to the Illinois shore, was begun in the first week in May. This dam is about three-fourths completed.

Rock	cubic yards	6,652.03
Brush	do	5,495.89
Total material used		12,147.92

The contractors have placed 17,733.15 cubic yards of material and earned $20,650.48, the total of their contract being $40,170. Mr. J. C. McElherne has acted as inspector to the contract, and given the same example of his skill and fidelity that he has always exhibited.

HYDRAULIC DREDGE.

Having become convinced by experience that effective dredging was a necessary part of the improvement of this portion of the river, and knowing that our powerful and effective dipper-dredge was not exactly the machine for cutting a temporary channel through a sand-bar, I recommended last year that a part of the appropriation be used for constructing a hydraulic dredge. This being approved, I have been giving much care and thought to this, which is in some degree an experiment. Powerful centrifugal pumps have done effective service in moving material from one place and putting it in another at Oakland, Cal., Washington Harbor, and other places. But to handle sand is a different affair, and where these pumps have been used for this purpose they have not been made to work as successfully as with other material.

After making a study of the subject, proposals were invited to furnish the machinery desired for this dredge as planned, and when opened, February 14, were rejected as being too high. Upon 15th of February bids were opened for the purchase by the United States of a small towboat, intended to carry this machinery.

Abstract of proposals.

No.	Names and addresses of bidders.	Name of boat.	Where registered.	Price.
1	James H. Rees and Samuel S. Brown, Memphis, Tenn.	R. A. Speed	Memphis, Tenn.	$13,000
2	A. J. Whitney, Le Claire, Iowa	Dick Clyde	Burlington, Iowa	4,000
3	A. F. Hollingshead, Clinton, Iowa	Lilly Turner	Dubuque, Iowa	7,500
4	John and Henry Specht, Dubuque, Iowa.	A. Reiding	do	3,500
5	Thomas M. Rees, Pittsburgh, Pa.	Glenwood	Pittsburgh, Pa.	7,700
6	Sea Lion Tow-Boat Company, Catlettsburg, Ky.	Sea Lion	Cincinnati, Ohio	12,000
7	E. M. Horton, G. L. Horton, E. R. Devol, H. C. Pownall, Pomeroy, Ohio.	Success	Wheeling, W. Va	6,500
8	James W. Gould and others, Pittsburgh, Pa.	Pacific	Pittsburgh, Pa.	14,000

The *Success* apparently filling the specifications at the lowest price, was inspected, accepted, and delivered in March.

She was at Hamburg Bay, in connection with the dredging there, and subsequently took the dredge and dumps, April 30, to Quincy, and May 3 to La Grange. Here a gravel wing-dam was begun above the head of Oyster Island, intended to produce a deposit in that chute so as to protect the closing-dam built there in 1884.

Operations were conducted until the fall of the river forced a suspension, when the dam was about three-fourths completed; 18,084 cubic yards of gravel were dredged and dumped on the line of the proposed dam to a distance of about 800 feet.

Meantime, after losing time experimenting with a sand-pump offered for sale, and not found satisfactory, bids were again invited and opened May 14, for a part of the machinery for a hydraulic dredge, of which the abstract is furnished.

Abstract of proposals for part of the machinery for a hydraulic dredge, received in response to advertisement of April 14, 1887, *and opened at 2 p. m. May* 14, 1887, *by Capt. E. H. Ruffner, Corps of Engineers, U. S. A.*

Number of proposals.	Name and residence of bidder.	Centrifugal pump, price.	Discharge pipes, price.	Total cost.	Remarks.
1	Joseph Edwards & Co., New York, N. Y.	$1,720.55	$2,274.00	$3,994.55	Edwards pump.
2	Lindon W. Bates, Kansas City, Mo.	3,450.00	....	3,450.00	Atlas pump; no bid on discharge pipe.
3	Goulds & Austin, Chicago, Ill	1,322.00	2,225.00	3,547.00	Van Wie pump.
4	John Specht, Dubuque, Iowa	*600.00	....	600.00	Van Wie pump; no bid on discharge pipe.
5	The Lawrence Machine Company, Boston, Mass.	1,850.50	2,158.00	4,008.50	Von Webber pump.
6	L. M. Rumsey Manufacturing Company, Saint Louis, Mo.	†600.00	2,867.50	3,467.50	Heald & Sisco pump.

* Second-hand pump and suction pipes.

† Pump and suction head only.

None of the bids filled the specifications entirely as to the pump itself, so the bid of John Specht, offering a second-hand Van Wie pump, was accepted, it being intended to ascertain from this what improvements or changes were needed in connection with the rest of the machinery.

The bid of the Lawrence Machine Company for the discharge pipe was accepted, and a contract entered into with them for it.

The main engine was contracted for with the Wright & Adams Company, of Quincy, their offer of $985 in the bids of February 14 being accepted. This engine will be delivered about the middle of July. A steam hoister, to work the rigging of the dredge, has also been ordered of the Wright & Adams Company for the sum of $760. This will be ready a week or so later than the other engine. To fit the *Success* for the purpose it was necessary to have the boilers moved back and certain other changes made. Bids were invited, but only one was received and opened, May 16. This was rejected as being too high. Informal offers were afterwards received, and the boat taken, May 31, to the marine railways at Rock Island, where the work was done speedily, cheaply, and well.

The force-pump needed to complete the machinery wanted will be taken from the *Coal Bluff*, and it is hoped that a trial may be made by August 1.

To carry the discharge pipes a distance of 500 feet, decked flat-boats were designed, and bids for five were opened March 23, 1887.

Abstract of proposals is given:

No.	Names and addresses of bidders.	Bid.
1	J. R. Morgan & Son, Clinton, Iowa	$8,000
2	Van Sant & Edwards, Le Claire, Iowa	4,925
3	Thomas G. Isherwood, Kansas City, Kans	4,400
4	Joseph Laoke, Quincy, Ill	6,450
5	Martin Von Hein, Le Claire, Iowa	*3,320
6	Thomas P. Morse, Saint Louis, Mo	6,750

* Accepted.

The bid of Mr. Martin Von Hein, of Le Claire, Iowa, was accepted, and the flats are building and will probably be delivered early in August. Mr. John Harrison is the inspector.

While the *Success* will be fitted primarily for use as a hydraulic dredge, yet her usefulness as a tow-boat, or as a tender to the dipper-dredge when working, will not be impaired.

Upon the completion of the hydraulic dredge and the trials necessary to ascertain what is needed to make it effective, it is probable that it will be too late to make any use of it this year.

When the working season closes this fall there will be no funds on hand, except those necessary for the care of the fleet during the winter and spring, and nothing is intended for the spring of 1888 until the action of Congress is known.

ESTIMATE FOR 1888-'89.

The general result of the work on this part of the river during the past nine years is not encouraging. The river is so large that the money appropriated was not enough to build works of contraction in sufficient number to control the river to such a degree as to enable an engineer to predict what the final result would be in depth of channel. At many places good has been done, chiefly by limiting the number of channels or by compelling the river at low water to run through such a narrow bed that the navigable channel can not shift to any great extent. At other places troublesome bars have been removed and brought to a semi-permanent position, where they are out of the way. Erosion has been largely controlled, and the movement of islands is less; and the banks are caving to a less degree than formerly. But it can not be stated that the general depth of the navigable channel has been increased to any degree. There is no reason to think that Congress will give a greater amount of money in the future than it has in the past. That sum, which has been on an average less than $100,000 a year, is not enough to carry on with success a plan of permanent improvement. It would be better to alter the plan of work than to pretend to continue in the present course. If a permanent improvement can not be had, then there remains only temporary relief to navigation by the full free using of dredging at times when it may be most needed. It has been shown by experience here that our large dipper-dredge can do exceedingly good work at times, and is both economical and effective where the conditions are favorable. But for extreme low water and digging temporary channels through sand-bars it is not suitable. We are preparing now a hydraulic dredge where the centrifugal pump is to be used in pumping up the sand and water from the desired channel, and delivering the same through discharge pipes at some point where the sand will not only be out of the way, but may help to turn the water in the direction of the proposed channel. Hydraulic dredges have been used with great success in moving silt at Oakland, Cal., Washington Harbor, and other places, and delivering the material at great distances. They have also been used on harbor bars and at the mouth of the Mississippi, but as yet, when working in clear sand, they have not done the work that should be done. In so far, then, the application of the principle here is an experiment, and the hope is that where good work has been done in one place, there is no valid reason why it could not be done also in another. I believe that patience and some mechanical skill will make our machine able to dig a channel through any one of our ordinary sand bars here, deep enough to induce the main flow of the water through it, in three days' work, provided we can make the machine do as well as other people have elsewhere. If this can be done there would be no difficulty in opening and maintaining a good navigable channel through this stretch of the river when the water is falling, by the use of two or three of these hydraulic dredges constantly operating and moving from the worst bar to the next one needing dredging. We shall be able to say more definitely about the probabilities after we have used our machine this summer and fall. Under any event, if it should not be a success, the machinery can be altered at small expense, and other pumps and devices used, until good results are secured. To build this dredge and equip it with flat boats has cost about $15,000, and to operate it will cost about $2,500 to $3,000 a month. It will be seen that much use may be made in this way of a small amount of money.

An estimate is therefore submitted of $50,000 for the maintenance and operation of the present dredging-machines and the extension of the practice of dredging temporary channels during the year.

To continue under the present approved plan of operations—contraction and protection works—surveys and estimates have been prepared for the construction of dams and protections at the following localities.

These works can all be built to advantage during one season's operations by the free use of stone, piles, brush, and poles, and by placing nearly all under contract.

Wing-dams and protection works opposite the mouth of the Des Moines River.	$10,000
Fox Island, closing-dams	9,700
Island 411, works	3,750

Island 412, works	$6,620
Tully Island, closing-dam and protection	12,900
Wing-dams and protection below Island 422	15,000
Cottonwood Island, protection	10,700
Orton's Island, closing dam and protection	8,000
Fabin's Island, closing-dam and protection	7,500
Wing-dams and shore protection between islands 433 and 434	25,000
Island 435, closing-dam and protection	12,600
Wing-dams and protection near Whitney's Bar	25,000
Turtle Island, shore protection	5,600
Closing-dams and shore protections for islands 440, 444, 445, and 446	24,450
Islands 451 and the next one, protections	2,500
Works near Fritz Island, exact character not yet determined upon	25,000
Closing-dams and protections at islands 465 and 466	10,500
Wing-dams opposite Island 465	9,500
Protection, Illinois shore opposite Grimes Island	17,000
Wing-dams opposite Island 474	11,000
Protection, islands 478, 479, and 480	5,600
Protection, Missouri shore opposite these islands	21,500
Island 482, closing-dam and protections	7,000
Westport Island and Island 486, closing-dam and protections	10,630
Island 487, protection	1,380
Wing-dams opposite foot of Sterling Island and protections to islands and shore near	27,430
Island 492, two closing-dams and protections	7,070
Protection, Island 494	3,000
Cuivre Island, closing-dam and protection	6,920
Cuivre Island to Island 503, closing-dam and protection	11,200
Protection, Island 505	2,000
Islands 508, 509, and 512, closing-dams and protections	9,100
Works in the vicinity of Island 510, character not yet determined upon	25,000
Protection to head Iowa Island	3,660
Closing-dams connecting together islands 516, 518, 519, 520, and 521, and suitable protections	21,500
Island 522, closing-dam and protection	2,420
Wing-dams near these islands to regulate the channels on both sides	15,000
Wing-dams above Island 524	20,000
Island 524, closing-dam and shore protection	15,500
Permanent works	468,230

There are extensive repairs now needed to a large number of the permanent works already constructed in the district, and about $65,000 can be well expended in this direction.

The total estimate will then be:

Dredging, construction, and operation of machines	$50,000
Construction of permanent works	468,230
Repairs to existing works	65,000
Total estimate for fiscal year 1888-'89	583,230

Unless funds are provided in time to allow of due advertisement and making of contracts no work can be done during the working season of 1888, which closes by November 1. There are no funds available for construction during the remainder of the present fiscal year, and the spring is the most desirable time for preparing for and beginning work.

Money statement.

Amount appropriated by act approved August 5, 1886		$150,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$54,735.24	
July 1, 1887, outstanding liabilities	75,914.82	
		130,650.06
July 1, 1887, amount available		19,349.94

Amount (estimated) required for completion of existing project is unknown.
Amount that can be profitably expended in fiscal year ending June 30, 1889 .... $583,230.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Capt. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

PRELIMINARY EXAMINATION OF BARS IN HAMBURGH BAY, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Quincy, Ill., January 17, 1887.

SIR: I have the honor to render the following report of a preliminary examination of the "bars in Hamburgh Bay," as required by sections 6 and 7 of the river and harbor act of 1886.

Hamburgh Bay is an outlet into the Mississippi of several drainage streams, which cover an area of perhaps 650 square miles. These streams, which would in many cases empty into the river direct, have been diverted by the levee known as the "Sny levee" into a common drainage outlet through Hamburgh Bay, the mouth of which is 12 miles below Clarksville and 31 above the mouth of the Illinois River. A railroad crosses the river at Louisiana, and below that road, in the angle between the Illinois and the Mississippi, is an area largely depending upon the rivers as the means of communication.

The shipping points of the vicinity in question are Hamburgh, 2 miles below the mouth of the bay, and Bayville, 1½ miles up the bay: When the stage of water permits there is a steamer, the *Bald Eagle*, which makes tri-weekly trips between Saint Louis and Clarksville, calling at Bayville both ways. When the water is too low for her to run, the smaller steamer *Dora* takes her place in the trade. It is known that considerable quantities of produce are shipped by these boats, but I have not been able to get an exact, or even an approximate, amount of freight handled.

Hamburgh Bay is also used as an ice-harbor at times to winter boats in, and this winter two of the largest boats on the river, the *Gun City* and the *Saint Paul*, besides the *Flying Eagle*, a smaller steamer, and two barges, are wintering there. These boats would not have gone there this year but for the dredging of a channel through the bar at the mouth of the bay this fall.

The bars are two in number. The one at the mouth is now being dredged in accordance with the terms of the appropriation bill of 1886, and is not now an obstacle, nor will be for a time at any rate. About a mile above the mouth is a second bar, which has only about 2 feet of water on it at low water, and which is a serious obstacle to the proper use of the bay.

For the reasons given above and supplemented by my knowledge of the fact that navigation interests of the locality are anxious that the bar should be removed, I have no hesitation in saying that I think the harbor is worthy of improvement.

From information already at hand, however, from prior surveys, it will not be necessary to cause further surveys to be made.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

APPENDIX Z.

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND DES MOINES RAPIDS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Upper Mississippi River, operations of snag-boats and dredge-boats, etc.
2. Mississippi River, from Des Moines Rapids to mouth of the Illinois River.
3. Mississippi River, from Saint Paul to Des Moines Rapids.
4. Des Moines Rapids, Mississippi River.
5. Operating and care of Des Moines Rapids Canal.
6. Dry dock at Des Moines Rapids Canal.
7. Removal of bar in Mississippi River, opposite Dubuque, Iowa.
8. Ice harbor at Dubuque, Iowa.
9. Harbors of refuge on Lake Pepin, at Lake City, Minnesota.
10. Harbors of refuge on Lake Pepin, at Stockholm, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 23, 1887.

GENERAL: I have the honor to transmit herewith the annual reports of operations in my charge during the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Z 1.

OPERATIONS OF SNAG-BOATS IN IMPROVEMENT OF UPPER MISSISSIPPI RIVER.

The usual item for work under this appropriation was omitted from the river and harbor act approved July 5, 1884, and at the beginning of the fiscal year the only available funds were the balances of allotments made from general appropriations for "improving Mississippi River from Saint Paul to Des Moines Rapids," and from "Des Moines

Rapids to Illinois River." By the act of August 5, 1886, $22,500 was appropriated for this special work.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions; the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating navigation through bridges; inspection and repair of existing works; formation of temporary or permanent channels through obstructing bars; and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi.

The plant used in connection with this work is the snagboats and dredges. At times, when the plant is not required in connection with this special work, it is used under general or special appropriations for work of permanent construction.

During July and August, 1886, the snagboat *General Barnard* was engaged removing snags and other obstructions between Saint Paul and the mouth of the Missouri. In September and October the boat and crew were detached for construction work in Crooked Slough.

On October 29 the *Barnard* was taken out on the ways at Dubuque, Iowa, and during the winter thoroughly repaired, repainted, and outfitted.

In May, 1887, the boat was again put in commission, and, with exception of the time from May 25 to June 10, has been employed upon snagging and inspection duty to close of the fiscal year.

The details of work accomplished, as well as much statistical information, are given in the appended report of Assistant Engineer C. W. Durham.

It appears to be generally admitted that the preservation of the navigation of the Upper Mississippi is a necessity in the interest of cheap freight rates and for the benefit of the general public; and, in considering the importance of such work and the amount of good resulting therefrom, it seems proper to consider all freight affected by river competition rather than the amount of freight actually carried on the river. In connection with this subject I would quote as follows from a statistical report for the calendar year ending December 31, 1886:

> The effect of the improvement of the Upper Mississippi River has been to cheapen the cost of water transportation. How much, it is impossible accurately to say; but it is fair to estimate such reduction in cost at about one-third. And besides, in low water, when formerly navigation almost ceased, there is now much less impediment, and, consequently, boats are enabled to carry large cargoes through without transfer and reshipment by rail. The railroads competing with the river are obliged during the season of navigation to reduce their freight charges in order to obtain business; but, from the time navigation closes in the fall until its reopening in the spring, the rates are from two to six times as large as during the time when boats are able to run. The average cost of transporting lumber and logs from the tributaries to various points on the Upper Mississippi River was, during 1886, $1 per 1,000 feet, B. M.; the railroad rates average $3 per 1,000 feet, showing a saving in water transportation of $2 per 1,000 feet. There were moved by water 1,315,120,020 feet, B. M., of logs and lumber, which indicates a saving on this one item of $2,630,240 as compared with transportation by rail. It is believed that the success of this important lumber business depends upon the use of the Mississippi River as a line of transportation.
>
> The amount of miscellaneous freight moved by boats during the year 1886 (337,713 tons) is less than the amount given for 1876; but this decrease is not any indication of a lessening in importance of the Mississippi River as a transportation route. Railroads now carry the larger portion of the miscellaneous freight, which was formerly transported by river; but they are compelled by river competition to carry

such freight during season of navigation at very low rates. The saving to commerce therefore resulting from the Mississippi River and its improvement comes from the resulting low rate of freight, and its money value must be calculated not only from freight moved by water, but also all freight moved by rail in competition with the water route. The effect of the river, if it be kept in a navigable state, and the saving to commerce, would be the same if not a pound of freight was actually transported by the Mississippi.

The saving to commerce on the miscellaneous freight actually moved by water is placed approximately at $800,000, which, with saving on lumber, logs, etc., already referred to, gives us about $3,500,000. This figure, it must be remembered, only represents the saving on freight actually moved by river. The immense additional saving to commerce from low rates on freight moved by rail in competition with the river can not at the present time be calculated.

But little definite information has been secured on the subject of marine insurance. The rates now charged, however, are about one-half to one-third as much as they were twelve years ago. But little marine insurance is now done, whereas in former years hulls and cargoes were invariably insured against accident as well as fire. The removal of snags and other obstructions from the channel of the river has brought about this beneficial result.

The work of the snag and dredge boats is an important one, furnishing immediate results and benefiting especially present interests of navigation.

As stated in my last two annual reports—

> I believe that permanent provision should be made for this work of snagging, wrecking, tree-cutting and pulling, clearing banks, finding and marking new channels, making surveys, soundings, and examinations; assisting boats in distress, watching and repairing existing improvements, investigating and supervising work on bridges, collecting physical data and statistics of commerce and navigation, and, in general, facilitating and reducing expenses of navigation.

To carry on this work properly, including the operation of a dredge, would cost approximately $30,000 per year, and, in my opinion, the work should be placed on the same footing as the canals now operated by the Government in accordance with the provisions of the act of Congress of March 3, 1881.

An appropriation of $30,000 is recommended for the next fiscal year. This estimate is based on necessary operating expenses and can not be reduced without affecting efficiency of work.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved July 11, 1870	36,000
By act approved March 3, 1871	42,000
By act approved June 10, 1872	42,000
By act approved March 3, 1873	25,000
By act approved June 23, 1874	25,000
By act approved March 3, 1875	25,000
By act approved August 14, 1876	30,000
By act approved June 18, 1878	41,500
By act approved March 3, 1879	20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
	524,640

Money statement.

Amount appropriated by act approved August 5, 1886	$22,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	17,911.37
July 1, 1887, amount available	4,588.63

Amount that can be profitably expended in fiscal year ending June 30, 1889 $30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1887.

MAJOR: I have the honor to present my annual report on improving Upper Mississippi River for the fiscal year ending June 30, 1887, together with some statistics of commerce and navigation:

OPERATIONS OF SNAGBOAT GENERAL BARNARD.

During the winter of 1885–'86, and up to July 23, 1886, the *Barnard* lay in the Des Moines Rapids Canal. On July 24, having been put in commission, she left Keokuk for below, arriving at Saint Louis on the 26th, and, returning, reached Keokuk on the evening of the 31st. On this trip obstructions were removed from the channel at or near Fox Island, Hackley's Island, Nigger Chute, Islands 412 and 428, Marion City, Louisiana, Clarksville, Thomas Chute, Red's Landing, Stag Island, Sandy Island, Sarah Ann Island, Maple Island, Piasa Chute, Carroll's Island, Blackbird Island, and Cottonwood Island.

On August 2, 1886, the *Barnard* left Keokuk for above, arriving at Saint Paul on the 15th. On the way up she removed obstructions from the channel at or near Montrose, Nauvoo, Fort Madison, Burlington, Oquawka, Benton Island, Johnson's Island, Keithsburg, Muscatine, Drury's Landing, Henley's Island, Cassville Chute, Johnsonport, Crooked Slough, Lansing, Bad Axe, Coon Slough, Picayune Chute, La Crosse Bridge, Dresbach, Richmond, La Moille, Fountain City, West Newton Chute, Alma, Trenton, Diamond Bluff, Prescott, St. Croix River, Hastings, Pine Bend, and Robinson's Island.

Leaving Saint Paul on the 16th, she proceeded down river as far as Louisiana, Mo., and returned to Keokuk on the 28th. On this trip snags, etc., were removed at or near Frenchman's Bar, Red Rock, Newport, Merrimac, Pine Bend, McMillan's Island, Nigger Chute, Ward's Island, Marion City, Turtle Island, Armstrong's Island, and Orton's Island.

From August 30 to September 5 the *Barnard* was engaged in towing a fleet of barges from Keokuk to Crooked Slough.

On October 29 she was taken out on the ways at Dubuque, and during the winter and spring was thoroughly repaired, repainted, and outfitted, at a cost of about $9,000.

May 9, 1887, the *Barnard* was again put in commission and proceeded to Keokuk, where she arrived on the 10th, and returning up river reached Saint Paul on the 21st. On this trip work was performed at or near Shokokon Slough, Keithsburg, Cassville Slough, Clayton, Picayune Island, Trenton, Coon Slough, and between Saint Paul and Hastings.

On the evening of May 25 she was laid up at Heytman's Landing, where she remained until June 10, when she again proceeded to Saint Paul, and from thence to Saint Louis on an inspection trip, and on her return trip had reached Hannibal at the close of the fiscal year. On this trip snagging work was performed at or near the mouth of the Missouri River, Alton Slough, Mason Chute, Squaw Island, Enterprise Island, Point Landing, McCann's Landing, Cuivre Island, Cap au Gris, Hogtown, Clarksville Chute, Hickory Chute, Mundy's Landing, Armstrong's Island, and Whitney's Bend.

SUMMARY OF OPERATIONS OF SNAGBOAT GENERAL BARNARD FOR FISCAL YEAR ENDING JUNE 30, 1887.

Snags removed	274
Leaning trees pulled back	29
Leaning trees felled and removed	1,208
Steam-boats assisted	2
Water-gauges established	2
Miles run	4,153

The snagboat *J. G. Parke* was taken out on the ways at Rock Island and thoroughly repaired. She is now serving as tender to dredge *Phœnix* in constructing foundation for pier at Lake City.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business interest on the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1886 to 92 raft-boats, valued at $720,000. Between Saint Paul and Saint Louis 74 saw-mills were operated by 67 wholesale lumber firms, having an invested capital of $33,000,000. Their manufactures in 1886 were: Lumber, 934,735,854 feet, B. M; lath, 267,888,340 pieces; shingles, 274,581,750 pieces. There were floated in the river for various distances in 1886, 781,720,120 feet B. M. logs and 533,400,000 feet B. M. lumber; total, 1,315,120,020 feet. Of the lumber, 218,800,000 feet came from the Chippewa, 30,000,000 from the St. Croix, and 92,500,000 from the Black. The total product, if shipped by rail, would load 108,760 cars of 12,000 feet each (about 20 tons each), the amount generally accepted by lumbermen as a car-load. Supposing an average length of car of 35 feet, it would load a train 721 miles in length, or 5,438 trains of 20 cars each. In addition to the manufacturers, there are large numbers of retail or distributing firms scattered along the river. The business of 1886 was not as large as in some former years, owing to low water and log jams in the tributaries.

Steam-boats and freight.—The principal steam-boat lines on the Upper Mississippi River are the Saint Louis and Saint Paul Packet Company, the Diamond Jo Line, and the Eagle Packet Company. There are also many independent boats carrying freight and passengers. During 1886 the amount of freight carried was 337,713 tons, and passengers, 965,803.

Statement of amount of freight received and shipped from Saint Louis by the Upper Mississippi River for five years.

Saint Louis.	1886.	1885.	1884.	1883.	1882.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received	140,880	117,445	129,895	126,330	135,540
Shipped	46,190	48,295	43,110	60,020	71,323
Total	187,070	165,740	173,005	186,350	206,863

1886.

Steam-boats and barges from Upper Mississippi arrived at Saint Louis	894
Tons of lumber and logs received at Saint Louis from Upper Mississippi River by raft	200,725
Steamboats and barges departed from Saint Louis for Upper Mississippi River	913

Receipts of lumber, logs, etc., at Saint Louis from Upper Mississippi, during 1885 *and* 1886.

Article.	1886.	1885.	Article.	1886.	1885.
	Feet.	*Feet.*		*Number.*	*Number.*
White pine lumber	124,154,170	131,753,637	Shingles	48,483,000	66,582,387
Cotton-wood lumber	3,925,500	3,763,800	Lath	37,154,600	51,127,567
			Pickets	862,330	571,450
Total	128,079,670	135,517,437	Total	86,499,930	118,281,404

Receipts and shipments of flour, grain, and provisions by Upper Mississippi River boats in 1886.

	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.	Pork.	Hams.	Meats.	Lard.
	Bbls.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bbls.*	*Lbs.*	*Lbs.*	*Lbs.*
Receipts	31,024	353,344	290,710	561,935	6,365	74,481	513	57,470	104,490	119,380
Shipments	2,693	112	156	325	....	560	241	13,137	49,551	5,538
Total	33,717	353,456	290,866	562,260	6,365	75,041	754	70,607	154,041	124,918

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Statement of steamers, barges, and rafts passing various bridges.

Locality of bridge.	Steam-boats.			Barges.			Rafts.		
	1886.	1885.	1884.	1886.	1885.	1884.	1886.	1885.	1884.
Hastings	820	1,009	845	909	1,316	980	25	4	8
Winona	4,570	5,126	2,992	974	848	905	1,860	1,973	2,607
La Crosse	4,347	4,775	5,160	587	475	542	1,485	1,797	1,959
Dubuque	4,766	3,561	3,451	1,221	826	1,119	728	882	1,401
Sabula	1,912	2,180	2,510	1,110	934	1,248	†23	(*)	1,097
Clinton	2,993	2,631	2,926	623	618	628	†543	†313	†474
Rock Island	2,393	2,331	2,708	139	153	203	784	747	1,083
Burlington	1,558	1,562	1,966	312	319	258	(*)	(*)	440
Keokuk	1,380	1,711	3,014	398	1,538	1,624	229	237	298
Quincy	1,708	1,509	1,658	770	602	430	291	296	418
Hannibal	1,515	2,135	2,863	494	458	504	(*)	(*)	†105
Louisiana	1,082	1,092	1,212	463	374	308	96	98	126

* No record of rafts. † Partial record.

Customs revenue and tonnage for the year ending December 31, 1886.

Port.	Collections.	Tonnage enrolled.	Vessels.
Saint Louis, Mo*	$1,635,242.45	161,448.98	253
Burlington, Iowa	....	5,317.63	53
Dubuque, Iowa	1,342.45	4,348.85	22
La Crosse, Wis	....	3,732.30	48
Galena, Ill	445.50	2,797.16	26
Saint Paul, Minn	136,837.06	3,407.39	40
Total	1,773,867.46	181,052.31	442

* Only a part of the Saint Louis statement applicable.

Internal revenue for the year ending December 31, 1886.

District.	Office.	Amount.
First Minnesota	Saint Paul	$556,399.33
Second Wisconsin	Madison	162,336.87
Sixth Wisconsin	Sparta	190,582.98
Second Iowa	Davenport	2,180,505.36
Third Iowa	Dubuque	190,297.43
Fourth Iowa	Burlington	81,697.24
Fourth Illinois	Quincy	329,705.08
Fourth Missouri	Hannibal	335,542.85
Aggregate	....	4,027,066.16

Very respectfully, your obedient servant,

C. W. Durham,
Assistant Engineer.

Maj. A. Mackenzie,
Corps of Engineers, U. S. A.

Z 2.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM DES MOINES RAPIDS TO THE MOUTH OF THE ILLINOIS RIVER.

An allotment of $5,000 was made in 1885 by the Secretary of War from the above-mentioned appropriation for the operation of the snagboat between Keokuk and the mouth of the Illinois River.

At the beginning of the year there was available of this allotment $1,722.96, which was expended in operating the snagboat *General Barnard*.

Details of the work may be found in the report of C. W. Durham, assistant engineer, under the head of "Improving Upper Mississippi River."

Money statement.

July 1, 1886, amount amount available	$1,722.96
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,722.96

Z 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER FROM SAINT PAUL TO DES MOINES RAPIDS.

Under this general appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully discussed in previous reports, consist in general in constructions of rock, brush, piles, and gravel, which close side chutes and reduce the low-water channel to a uniform width, and in the protection of caving banks.

There was available at the beginning of the fiscal year, $8,869.25, and $382,500 were appropriated by the act of Congress of August 5, 1886. There has been expended during the year, including allotments for buoying Rock Island Rapids, removal of wrecks and other obstructions, cutting temporary channels through sand bars, and thorough repair of plant, $131,038.73.

Owing to the very small balance available at beginning of year, the late date at which the new appropriation became available, and the time required for preparations, work of construction and repair was not commenced in 1886 till the latter part of August. It was continued, under a project submitted August 31, till close of navigation, between Saint Paul and Hastings, at Chimney Rock, Crooked Slough, and Shokokon, on Rock Island Rapids, and between Dallas and Pontoosac.

A new project for the expenditure of the available balance, $278,500, was submitted February 11, 1887, and approved. The allotments proposed by this project were as follows:

1. For construction of dams and shore protections between Saint Paul and the head of Lake Pepin	$50,000
2. For constructing dams and shore protections from Read's Landing to Minneiska	20,000
3. For constructing dams and shore protections from Minneiska to Winona and at foot of Coon Slough	15,000
4. For constructing dams and shore protections from Homer to Queen's Bluff	25,000

5. For constructing dams and shore protections in the vicinity of Crooked Slough	$20,000
6. For constructing dams and shore protections from Guttenberg to Waupeton	20,000
7. For constructing dams and shore protections from Sand Prairie to Savanna	30,000
8. For work at Duck Creek Chain and other points on Rock Island Rapids	10,000
9. Buoyage of Rock Island Rapids	500
10. For constructing dams and shore protections in vicinity of Andalusia	3,000
11. For constructing dams and shore protections from Fairport to Muscatine	25,000
12. For constructing dams and shore protections from head of Otter Island to Nauvoo	30,000
13. For surveys and gauges	5,000
14. For repair, care, and outfit of plant	10,000
15. For construction of 2 steel steam-launches	10,000
16. For operating expenses of United States dredging plant in cutting new channels at obstructed points	5,000
Total	278,500

Subsequent to the approval of this project it was decided by the War Department that the $15,000 conditionally appropriated by Congress for continuing test of the Adams Flume should, in accordance with the evident wish of Congress, be reserved for Mr. Adams's benefit. This led to the temporary suspension of work as laid out under items 11 and 15.

In April the following contracts were entered into:

1. With Jacob Richtman for the construction of dams and shore protections between Homer and Queen's Bluff, at $1.53 per cubic yard of rock in place, and 72 cents per cubic yard of brush in place.
2. With Sid. J. Truax for the construction of dams and shore protectections between Guttenberg and Waupeton, at $1 per cubic yard of rock in place, and $1 per cubic yard of brush in place.
3. With A. J. Whitney for the construction of dams and shore protections from Sand Prairie to Savanna, at $1.30 per cubic yard of rock in place, and 70 cents per cubic yard of brush in place.
4. With A. Kirchner and S. D. Van Gorder, for furnishing 10,000 cubic yards riprap rock, and delivering the same on United States barges between Fountain City, Wis., and Winona, Minn., at 75 cents per cubic yard.
5. With Wm, Roberts & Co., for furnishing 10,000 cubic yards riprap rock and delivering the same on bank of river between Burlington and Montrose, Iowa, at 48 cents per cubic yard.

The work near Homer, and the getting out of rock at Fountain City and Nauvoo, under above contracts, has been commenced. The other works will be started immediately.

Repairs to the closing dam in Rollingstone Slough by agreement, and work at Andalusia by day's labor, were carried on in April and work on Rock Island Rapids by agreement was commenced. Work with Government plant was resumed the latter part of May, 1887, in the vicinity of Shokokon, Drew's Prairie, and below Fort Madison, at Crooked Slough, and between Saint Paul and Hastings.

The details of the work accomplished during the past year are given in the reports of U. S. Civil Engineer M. Meigs and Assistant Engineer C. W. Durham.

SNAG AND DREDGE BOATS.

During a portion of the year, there being no special appropriation available for operating snag and dredge boats, such work was carried on under an allotment from the general appropriation. In addition to the usual snagging work, four wrecks were removed by dredge, three channels cut through bars, and an obstructing tow-head at the foot of Coon Slough was removed.

BUOYS ON ROCK ISLAND RAPIDS.

As usual an allotment was made for buoying the Rock Island Rapids. The buoys, which are fully described in last Annual Report, were taken in November 3, 1886, and replaced in March, 1887. These buoys have proved of great service to the interests of navigation; and, in connection with the electric lights of the steamboats, enable the rapids to be passed under conditions which were formerly prohibiting.

PLANT.

During the year ending June 30, 1886, owing to small amount of money on hand and uncertainty as to future operations, but few repairs were made to plant. This necessitated during past year quite extensive repairs and outfitting, in anticipation of present season's operations.

SURVEYS AND GAUGES.

Surveys of limited extent have been made during the year to determine the effect of work, and the nature of improvement required at points where work was to be carried out. Gauge-readings at numerous points have been obtained as heretofore.

BRIDGES OVER THE UPPER MISSISSIPPI RIVER BETWEEN SAINT PAUL AND KEOKUK AND FACILITATING NAVIGATION THROUGH THEM, UNDER SECTION 8, RIVER AND HARBOR ACT OF JULY 5, 1884.

Two new bridges have been commenced during the year—a railroad bridge at Fort Madison, Iowa, under an act of Congress, and a highway bridge at Dubuque, Iowa, without act of Congress. Subsequent to commencement an act was secured legalizing the Dubuque Bridge.

In October, 1886, a boom was placed above the Burlington Bridge. This boom, now about 600 feet long, will soon be lengthened 400 feet.

An additional boom for the benefit of rafts has been placed in position above the raft span of the Clinton Bridge.

The guard-fence built in connection with the Keithsburg Bridge has been lengthened, but the direction given the extension is not strictly in accordance with instructions given or such as is required.

A boom 1,000 feet long will be immediately placed above the draw-span of the Fort Madison Bridge.

In December, 1886, work for facilitating navigation through the bridges at Quincy, Hannibal, and Louisiana was transferred to Capt. E. H. Ruffner, Corps of Engineers.

Some work for facilitating navigation has now been carried out at all bridges crossing the Mississippi River between Saint Paul and Keokuk, excepting at the latter point and Saint Paul. No work has yet been considered for the Saint Paul bridges, and at Keokuk some much needed work is delayed by a temporary complication due to an item in the appropriation for improving the Des Moines Rapids and is referred to under the head of report.

While much good has resulted from the work already carried out at the various bridges, it is evident that in most cases additional protection is desirable, and it will be gradually called for.

THE ADAMS FLUME.

The acts of Congress of March 3, 1879, and August 2, 1882, granted $28,000 to M. J. Adams for practically testing what he terms the "Adams Flume." This money has all been expended by Mr. Adams for experimental work and the development of certain ideas. No pipe has yet been put in the water and no practical results of any kind have been secured.

The act of Congress of August 5, 1886, provided under item for "Improving Mississippi River from Saint Paul to Des Moines Rapids" that the "amount of $15,000, or so much thereof as may be necessary, may be used by the Secretary of War, in his discretion, for continuing the practical test of the flume invented by M. J. Adams, the said test to be made under the supervision and direction of said Adams."

In accordance with the instructions of the Secretary of War, I submitted under date of August 21, 1886, a report upon the condition of plans, work, and property. From this report the following extract is taken:

> The description of the property represents to a certain extent the condition of the work. No pipe has yet been put in the water, and consequently no test of Mr. Adams' method of improving the Mississippi River has been made. I am informed that about half a mile of pipe was some years ago put together on shore, with what results I can not say. For past three years, subsequent to the exhaustion of Mr. Adams' appropriation, I understand nothing has been done and material on hand has naturally deteriorated.
>
> Supposing that the days of preliminary experiments and changes are over and the form of pipe now on hand is that which Mr. Adams proposes to use, the condition of the work would appear such as to permit, with a little repair, a trial in the river of about half a mile of pipe.
>
> I have a general knowledge of the plans of Mr. Adams, but certain conditions of the appropriations under which he has been carrying on his work have been such as to prevent my obtaining any information as to detailed operations.
>
> My general impression has been that while Mr. Adams has great faith in his invention and knew the result he expected to accomplish, he had no very definite ideas as to practical methods or details. This has, I think, caused many changes in such details, and has already resulted in the expending of a much larger sum of money than was necessary.
>
> The expenditure of the $15,000 item conditionally appropriated by Congress for continuing the test of Mr. Adams' invention being at the discretion of the Secretary of War, permits an expression of opinion as to the merits of the work under consideration.
>
> I do not hesitate to express the opinion that Mr. Adams' line of pipe when put to a practical test will prove to him a great disappointment and will fail to deepen the Mississippi River or improve its channel; and I feel that a further expenditure of any portion of the $15,000 in connection with Mr. Adams' experiment would be throwing away money which is much needed for legitimate and practical work on river improvement. But possibly the action heretofore taken by Congress may be considered such as to make a completion of Mr. Adams' experiment proper and desirable. If this be so, and if the law permits proper restrictions to be placed on disbursements, I would respectfully suggest that any further work and expenditure be limited strictly to such as are absolutely necessary for placing in the water and practically testing the pipe now on hand and in serviceable condition. The trial of half a mile of pipe, or any length available, will practically test Mr. Adams' theories as well as the trial of 3 miles, as proposed by him. If the work be properly managed and the expenditures from the $15,000 be confined to such as have a legitimate bearing on the work suggested, the pumping outfit can be made serviceable, the pipe put in the river, and the experiment completed at comparatively small cost and in a brief space of time.

It being finally decided by the War Department that it was the intention of Congress to permit a further expenditure, authority was granted Mr. Adams to continue operations under certain restrictions which required him to limit his work to such as was absolutely necessary for placing in the water and practically testing the pipe on hand and in serviceable condition.

Under the authority granted, Mr. Adams is slowly resuming operations, and as the length of pipe to be tested has been by agreement reduced to 500 feet, an end of operations should be reached in a short time if work be carried on with any system and with any fixed object in view; but that such end will be actually reached under present conditions of management can not be predicted.

GENERAL REMARKS.

The works heretofore carried out have continued to exercise a most beneficial effect, and at points where improvements have been carried to completion serious trouble has been done away with; but new difficulties are liable to arise at points where no work has yet been carried out. The results already accomplished show that the Mississippi River between Saint Paul and the Des Moines Rapids can be put in such condition as to make navigation sure and comparatively easy; but to accomplish this requires time and continued work under liberal appropriations. The river was extremely low last fall and is now in same condition, and temporary difficulty has been experienced at unimproved points; but the ability of the works of construction, in connection in some cases with dredging, to rapidly make and maintain a navigable channel at such points, has been fully demonstrated.

As has been heretofore explained, it is desirable, if the radical improvement of the Upper Mississippi is to be continued and carried to a successful completion, that it should be carried on under liberal appropriations. As an amount that can be expended during the fiscal year ending June 30, 1889, I submit an estimate of $1,500,000. It will be remembered that this is an estimate for carrying on work over about 500 miles of river; and though the estimate is apparently for one work, it in fact covers a very large number of works, which, while belonging to one system, are, in fact, independent of each other. In giving an amount that can be expended in one year, it is to be understood that the economical and proper expenditure of such a sum must be preceded by adequate preparation. Such preparation requires time and can not be made till the means for carrying on the work are in sight.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "Improving Upper Mississippi River." These statistics do not, in any sense, indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi, in an improved condition, has upon freight rates must be taken as a measure of its importance.

The existing project for this work is one of general methods and plans rather than details. No definite estimate of cost of completion can well be given. Projects for the expenditure of each appropriation, in accordance with approved plan and methods, are presented in lieu of a general project for completion of work.

SUMMARY OF EXPENDITURES FOR FISCAL YEAR ENDING JUNE 30, 1887.

Amount expended by vouchers	$131,130.64
Received from sale of fuel	91.91
Total	131,038.73
Distributed as follows:	
Saint Paul to Hastings	31,881.94
Read's Landing to Minneiska	641.83
Chimney Rock	1,355.66

Rollingstone	$1,011.22
Homer to Queen's Bluff	6,513.48
Coon Slough	124.58
Crooked Slough	33,534.16
Guttenberg to Waupeton	77.52
Rock Island Rapids	7,690.20
Andalusia	3,791.85
Otter Island to Nauvoo	16,709.46
Buoys on Rock Island Rapids	661.57
Wrecks removed (*Hastings*, *Wabasha*, and *Royal Arch*)	1,694.20
Snagboat *General Barnard*	2,836.67
Surveys and gauges	2,299.42
Dredge *Phœnix*, cutting new channels	1,927.92
Purchase, repair, and care of plant	18,287.05
Total	131,038.73

GENERAL STATEMENT OF RECEIPTS AND EXPENDITURES.

Expended by vouchers from commencement of improvement to June 30, 1887, inclusive		$1,303,759.48
Deduct amount received from sales of fuel	$727.60	
Deduct amount received from sale of rock	1,078.05	
		1,805.65
Net cost of improvement		1,301,953.83
Amount set aside for testing Adams' flume		20,000.00
Amount set aside for office of Chief of Engineers		1,354.50
Balance, July 1, 1887		259,191.67
Total appropriated		1,582,500.00

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	$250,000
By act approved March 3, 1879 *	100,000
By act approved June 14, 1880	150,000
By act approved March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved July 5, 1884	250,000
By act approved August 5, 1886 †	382,500
Total	1,582,500

Net expenditures on the various sections of the river between Saint Paul and Des Moines Rapids from commencement of improvement to July 1, 1887.

Locality.	Distance.	Amount.
	Miles.	
Saint Paul to Hastings	27	$306,583.64
Hastings to head of Lake Pepin	32	46,573.52
Head of Lake Pepin to Alma	36	184,934.80
Alma to Winona Bridge	29	190,419.24
Winona Bridge to La Crosse Bridge	31	49,221.82
La Crosse Bridge to McGregor Bridge	72	73,168.49
McGregor Bridge to Dubuque Bridge	59	50,442.80
Dubuque Bridge to Clinton Bridge	67	17,173.48
Clinton Bridge to Rock Island Bridge	40	14,564.05
Rock Island Bridge to Keithsburgh	58	35,971.04
Keithsburgh to Des Moines Rapids	60	150,981.61
Surveys and meter-work		65,074.23
Snag and dredge boats and wrecking		18,286.51
Facilitating navigation through bridges		1,197.06
Plant at estimated value		97,361.85
Total		1,301,953.83

* $20,000 set aside for testing Adams' flume.

† $15,000 set aside for testing Adams' flume.

Money statement.

July 1, 1886, amount available	$8,869.25	
Received from sale of fuel	91.91	
Amount appropriated by act approved August 5, 1886	*382,500.00	
		$391,461.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	132,269.49	
July 1, 1887, outstanding liabilities	3,529.03	
		135,798.52
July 1, 1887, amount available		*255,662.64
Amount that can be profitably expended in fiscal year ending June 30, 1889.		1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., April 14, 1887, *at* 2 *p. m. for furnishing cordage and oakum.*

No.	Names and addresses of bidders.	13,000 pounds manilla rope, per pound.	14,000 pounds lath-yarn, per pound.	100 bales oakum, per bale.	Total.
		Cents.	*Cents.*		
1	H. Channon Company, Chicago, Ill	11¾	9	$3.40	$3,127.50
2	Ward & Brady, Saint Louis, Mo	11⅝	8¼	3.25	2,993.75
3	James J. Hawk, Saint Louis, Mo	11⅜	8⅜	3.33⅓	2,984.58
4	George B. Carpenter & Co., Chicago, Ill	11⅝	9	3.50	3,121.25
5	W. D. Bangs, Saint Louis, Mo. †	11⅜	8	3.50	2,948.75

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 *p. m., April* 29, 1887, *for construction of dams and shore protections of brush and rock between Homer, Minn., and Queen's Bluff, Minn.*

No.	Names and addresses of bidders.	Rock in place (10,400 cubic yards).	Brush in place (7,000 cubic yards).	Total.
		Per cu. yard.	*Per cu. yard.*	
1	Samuel McDonald, Casselton, Dak	$1.48	$1.06½	$22,847
2	A. Kirchner and S. D. Van Gorder, Fountain City, Wis	1.40	1.00	21,560
3	Jacob Richtman, Fountain City, Wis. †	1.53	.72	20,952
4	Sid. J. Truax, Hastings, Minn	1.48	1.00	22,392
5	A. J. Whitney, Rock Island, Ill	1.59	.75	21,786

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 *p. m. April* 29, 1887, *for construction of dams and shore protections of brush and rock between Guttenberg, Iowa, and Waupeton, Iowa.*

No.	Names and addresses of bidders.	Rock in place, 9,000 cubic yards.	Brush in place, 4,500 cubic yards.	Total.
		Per cu. yd.	*Per cu. yd.*	
1	Samuel McDonald, Casselton, Dak	$1.45	$1.06½	$17,842.50
2	John Specht, Dubuque, Iowa	1.49	.79	16,965.00
3	Sid. J. Truax, Hastings, Minn.†	1.00	1.00	13,500.00
4	Jacob Richtman, Fountain City, Wis	1.35	.63	14,985.00
5	A. J. Whitney, Rock Island, Ill	1.39	.70	15,660.00
6	Patterson Bros., Keokuk, Iowa	1.60	.80	18,000.00

---

*$15,000 assigned to the test of the Adams' flume.

† Accepted.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m. April 29, 1887, for construction of dams and shore protections of brush and rock between Sand Prairie and Savanna, Ill.

No.	Names and addresses of bidders.	Rock in place, 12,400 cubic yards.	Brush in place, 8,300 cubic yards.	Total.
		Per cu. yd.	*Per cu. yd.*	
1	Samuel McDonald, Casselton, Dak	$1.65	$1.25	$30,835
2	Jacob Richtman, Fountain City, Wis	1.35	.63	21,969
*3	Sid. J. Truax, Hastings, Minn	1.25	1.00	23,800
4	A. J. Whitney, Rock Island, Ill*	1.30	.70	21,930
5	Patterson Bros., Keokuk, Iowa	1.50	.75	24,825

*Accepted.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m. April 29, 1887, for furnishing 15,000 cubic yards riprap rock, and delivering the same on bank of river in vicinity of Alma, Wis.

No.	Names and addresses of bidders.	Per cubic yard.	Total.
1	Samuel McDonald, Casselton, Dak	$1.25	$18,750
2	Prince, Vanderbilt & Bright, Lynxville, Wis	1.00	15,000
3	William Witte, Read's Landing, Minn*	.527	....
4	N. Martin, Hastings, Minn	.85	12,750
5	A. Kirchner, Fountain City, Wis	.87	13,050
6	D. Keleher, Davenport, Iowa	.80	12,000

* Bid for 1,422 cubic yards only.

All bids rejected, it being more economical and advantageous to the Government to purchase the rock in open market.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m. April 29, 1887, for furnishing 10,000 cubic yards riprap rock, and delivering the same on United States barges between Fountain City, Wis., and Winona, Minn.

No.	Names and addresses of bidders.	Per cubic yard.	Total.
1	Samuel McDonald, Casselton, Dak	$1.25	$12,500
2	A. Kirchner and S. D. Van Gorder, Fountain City, Wis*	.75	7,500
3	D. Keleher, Davenport, Iowa	.95	9,500

*Accepted.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m. April 29, 1887, for furnishing 10,000 cubic yards riprap rock, and delivering the same on bank of river between Burlington and Montrose, Iowa.

No.	Names and addresses of bidders.	Per cubic yard.	Total.
1	Samuel McDonald, Casselton, Dak	$1.25	$12,500
2	William Roberts & Co., Nauvoo, Ill*	.48	4,800
3	D. Keleher, Davenport, Iowa	.90	9,000

*Accepted.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1887.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from Saint Paul, Minn., to vicinity of Burlington, Iowa, for fiscal year ending June 30, 1887:

SAINT PAUL TO HASTINGS.

Operations in 1886.—Owing to scarcity of funds work was not commenced until late in August on this section of the river. Mr. J. D. DuShane, superintendent, was in charge of operations in the field during the season, and from his report I give the following extracts, which describes this important work in detail:

"The most troublesome places to navigation between Saint Paul and Hastings during the season were at Red Rock and Merrimac, where the channel had changed to the banks opposite these places. As the Red Rock bar seemed the greater obstruction, work was begun there August 23. To restore the channel to the Red Rock side, three wing-dams were constructed extending from the right bank. * * * Along the Red Rock shore there existed three vertical ledges of rock, varying in length from 40 to 100 feet, which overhung the water and proved dangerous to navigation. These points were removed by blasting, making a smooth shore.

"The plant was moved to Merrimac on September 14, and work was begun to correct the course of the channel to the right bank and to confine it there. Five wing-dams extending from the left bank were built.

* * * * * * *

"At the upper end of Merrimac rocks a ledge 200 feet long and from 4 to 8 feet above low water, overhanging the water, was removed by blasting, the rock being broken up quite small and allowed to drop into deep water. The shore was sloped and a quantity of the rock, made into riprap, was placed thereon, forming a surface similar in appearance to the ordinary shore protection. Several smaller overhanging rocks below this point were removed. These points had always proved dangerous to navigation, many boats and barges having been injured by striking them. The upper ledge formed a shoulder, so to speak, near the head of the rocks, the shore above bowing inward; the channel was close and the draught of water set strongly against the rocks. The removal of only the most dangerous points was undertaken. This work was performed by days' labor; it was begun October 14 and finished October 27.

* * * * * * *

"On October 16 the plant was moved to Newport. Work was begun the same day and continued to November 11; during this time there were constructed 5 dams extending from the right bank (Island No. 5), and one piece of shore protection on the left bank. The wrecked barge opposite Newport had become a dangerous obstruction to navigation, and the channel threatened to leave the main part of the river and pass between the wreck and Island 5; in fact, some boats were already running that way, the water being deeper, though the passage between the wreck and the island was very narrow. * * * On account of narrowing the river by these dams it became necessary to protect the bank opposite. This is a hard bank, but owing to an underlying seam of sand below the water-surface, which was constantly being washed out by the current, the bank was continually though gradually caving in. Beginning at a point about 200 feet below the Diamond Jo warehouse this bank is protected for a distance of 1,910 feet extending down the river; the protection is 35 feet wide and is carried to within 2 to 3 feet of the top of the bank. Owing to the character of the bank it was thought that a very light protection above water would be sufficient, and on this account a layer of brush about 4 inches thick was used, covered with a lighter layer of rock than usual.

"Work at Newport was finished November 11, and the plant was moved to the foot of Grey Cloud Island, where it was necessary to protect the lower end of this island and the bar, formed above the dam, joining Grey Cloud Island with Island 17. This is a very light bank composed of sand and sawdust, and a protection of the usual thickness was carried to the top of the low bank. This protection extends down the river 1,100 feet and is 35 feet wide. This work was finished November 16 and the plant was laid up in Boulanger Slough the next day.

"Wherever works of improvement had been constructed in previous years no trouble was experienced by boats during the past season; and the dams at Red Rock and Merrimac were so located and their construction so regulated as to permit boats to use the existing channel while a new one was being cut out by the action of the current, thus securing navigation for the largest steamers engaged in the commerce of the

Upper Mississippi River, they having made regular trips through to Saint Paul without interruption during the period of lowest water.

* * * * * * *

"It was hoped that during the season some work at Pig's Eye could be accomplished; but as a very late start was made it was impossible to reach this point. The channel here has remained about as it was during the latter part of the season of 1885, with perhaps a slight increase in depth over the gravel-bar. Two dams should be built here during the coming season to confine the water to the right bank, the river at this point being very wide. Possibly some shore protection may become necessary along the right bank.

"Frenchman's Bar, just above Pig's Eye, after remaining quiet for a number of years, gave evidence during the past season of becoming troublesome at a not very distant day, and work near the lower end of this bar may become necessary; but this can only be determined after the opening of navigation.

"The crossing at the foot of Island No. 14 has been very flat and growing bad during the past two years. It would seem desirable to put in a couple of dams here, in order to confine the water to one of the three poorly-defined channels now existing."

List of dams and shore protections constructed and repaired, and of materials used during the season of 1886.

Works.	Length.	Rock.	Brush.	Poles.	Piles.	Stringers.
	Feet.	*Cu. yds.*	*Cu. yds.*	*Number.*	*Lin. ft.*	*Ft. B. M.*
Sheet 2, pile dam No. 21	680	523.3	1,161.0	1,125	704	1,600
Sheet 2, pile dam No. 22	400	477.3	1,260.1	1,200	648	1,600
Sheet 2, pile dam No. 23	400	359.8	716.4	700	756	800
Sheet S. P., foot Island No. 4	Repair.	53.5	....	....	....	....
Sheet 3, pile dam No. 10	450	514.1	1,155.9	1,100	720	1,800
Sheet 3, pile dam No. 11	470	555.7	1,270.9	1,220	736	920
Sheet 3, pile dam No. 12	300	252.6	569.2	545	288	560
Sheet 3, Dam No. 13	475	304.6	512.7	275	32	....
Sheet 3, Dam No. 14	400	603.9	910.6	1,000	64	....
Sheet 3, Dam No. 15	265	581.0	830.8	950	48	....
Sheet 3, pile dam No. 16	200	342.5	440.8	450	256	760
Sheet 3, Dam No. 17	250	304.3	550.9	588	54	....
Sheet 3, pile dam No. 18	250	342.6	380.4	400	412	560
Sheet 3, pile dam No. 19	275	246.2	665.0	650	464	560
Sheet 3, Dam No. 17	Repair.	467.9	447.9	450	....	....
Sheet S. P., above Dam No. 9	630	477.9	560.1	250	....	....
Sheet S. P., below Dam No. 9	Repair.	351.2	....	....	....	....
Sheet S. P., below Newport	1,910	1,592.3	1,593.8	1,400	....	....
Sheet 4, S. P., foot Grey Cloud Island	1,100	874.1	1,083.2	1,000	....	....
Total	....	9,224.8	14,109.7	13,303	5,182	9,160

SUMMARY OF EXPENDITURES FOR WORKS FOR IMPROVING THE MISSISSIPPI RIVER BETWEEN SAINT PAUL AND HASTINGS DURING THE SEASON OF 1886.

Materials		$11,533.24
Labor		5,383.17
Fuel		906.72
Subsistence		1,491.51
Expense		991.18
Special superintendence and contingencies		1,131.04
		*21,436.86
Less—		
Materials on hand	$242.97	
Pay-rolls, "Removing rocks"	362.99	
Expense at boat-yard	232.00	
		837.96
Total cost of materials put in		*20,598.90

* * * * * * *

Operations in 1887.—Work in 1887 was commenced on June 6 at Red Rock, and continued in that locality during the month. Details are given in extracts from the report of Mr. J. D. DuShane, superintendent in local charge.

* * * * * * *

---

* General office expenses and deterioration of plant not included.

"After towing the working fleet from Boulanger Slough to Red Rock, operations were begun on the 6th at the lower Red Rock Crossing, which was in bad condition, and work was continued at that place during the remainder of the month.

"The river was wide and the crossing long and crooked. In order to confine the channel to narrower limits Dam 18 (sheet 2) was repaired and extended in length 200 feet, and changed from a pile-dam to a solid brush and rock dam. One dam was built between Dams 17 and 18 (sheet 2); two dams were constructed below Dam 18 (sheet 2); and a third partly completed. Work of repairing and extending Dam 1 (sheet 3) was begun. Slight repairs were made to the shore protection opposite Island No. 3.

"While a large movement of sand has taken place, as rapid deepening of the channel has not occurred as was to have been expected, though the crossing is now much straighter and will continue to improve daily as the sand passes down.

* * * * * * *

"The amount of material used in these works during the month is as follows:

Rock	cubic yards	2,840.9
Brush	do	6,394.5
Total		9,235.4

* * * * * * *

READ'S LANDING TO MINNEISKA, MINNESOTA.

The work proposed for this district consists chiefly in the repair, strengthening, and extension of existing dams and shore protections and in the construction of new work near Pine Island, for which $30,000 has been allotted for 1887.

Nothing has been done except collection of material.

CHIMNEY ROCK.

In the fall of 1886, the works at Chimney Rock being in bad condition, Jacob Richtman, of Fountain City, Wis., was employed to make repairs to the same at $1 per cubic yard for rock. The break in the dam was about 175 feet long and from 6 to 20 feet deep. The shore protection at the east end of the dam was entirely gone, and that at the head of Island No. 53 in very bad condition. Work was commenced November 5 and suspended on the 18th, on account of cold weather.

Amount of rock put in, 1,120 cubic yards.

Mr. W. A. Thompson was the local inspector.

It is proposed to complete the repairs the present season.

ROLLINGSTONE.

In April, 1887, some repairs were made to the closing dam in Rollingstone Slough. The west end was cut down 2 feet and the east end was raised to grade; 719.6 cubic yards of rock were put in the work by Jacob Richtman, of Fountain City, Wis., at a cost of $1 per yard.

Mr. W. A. Thompson was the local inspector.

HOMER TO QUEEN'S BLUFF.

For operations in 1887 an allotment of $25,000 was made for this stretch of river, 14 miles in length.

It is proposed to accomplish such portions of the following-named work as can be constructed with the funds available, viz., completion of dam across Blacksmith Slough; building of closing dams at the chute of Island No. 87, La Moille Chute, Richmond Chute, the chute between Islands Nos. 81 and 82, and the chute of Island No. 89; and also some repairs and extensions of existing works, and the raising of the dams at Queen's Bluff. Work under contract with Jacob Richtman, of Fountain City, Wis., was commenced May 30, and continued until the close of the year, and has thus far consisted in the construction of a dam across La Moille Chute, some repairs to Dam No. 2 (sheet 19), repairs to shore protection on Island No. 81, and an extension of the same for 250 feet. The La Moille Chute Dam is 960 feet long. For about 300 feet of its length four courses of brush were used, and for the remainder three courses, except for about 200 feet, where it required but two courses.

The price paid for material in place is, rock $1.53, brush 72 cents, per cubic yard; and there were put in to the close of the year, of the former 3,231, and of the latter 1,824 cubic yards.

Mr. G. A. Marr is the local inspector.

COON SLOUGH.

On the 18th and 19th of May, 1887, the small island at the foot of Coon Slough, so long a bad obstruction to rafts, was removed by United States dredge *Phœnix*.

CROOKED SLOUGH.

Operations in 1886.—On August 20, 1886, the *General Barnard*, on her way down the river from Saint Paul, left seven barges (Nos. 1, 7, 8, 14, 27, 76, and 71) at Heytman's Landing, about 1 mile above the head of Crooked Slough.

From August 29 to September 4 the *Barnard*, assisted by tow-boat *Fury* and steam-launches *Stella* and *Louise*, was employed in transferring from the Des Moines Rapids Canal to Crooked Slough a fleet consisting of quarter-boat 75, building-boat 41, grasshopper 42, and barges 22, 36, 65, 68, 78, 97, 100, 101, and 102. On the arrival of this fleet there were available for work 16 barges, besides building-boat, quarter-boat, and grasshopper, and the two steam-launches *Louisa* and *Stella*, the *Barnard* having been laid up and the *Fury* having been sent on to Saint Paul. On September 5 an examination of Harper Slough was made in order to fix upon a location for the proposed closing dam. On the 6th work on the Harper Slough Dam (No. 1, sheet 28) was begun and continued until October 4, when the work was completed.

This dam, 686 feet in length with shore protections 355 feet long, closes Harper Slough, and has its crest about 4½ feet above low water of 1864. It is located about one-fourth mile from the head of the chute, and about 1 mile below Heytman's Landing. For mooring purposes four light timber cribs were used, and they served admirably. The bank at the east end of the dam being soft, and the island much cut up by sloughs, the brush was carried to the top and a very heavy covering of rock was used.

The fall at the dam when completed was about 14 inches.

On the 8th of September a dam was commenced to close Swift Slough, which drew out considerable water from Crooked Slough, making from the left bank about 1 mile below head of the slough and emptying into the Winneshiek. This dam (No. 2, sheet 28), with adjoining shore protection above and below, was finished September 23, and was afterwards somewhat strengthened, as it had settled materially and gave evidence of being undermined. The work in clearing the shores and sloping same was very heavy. Above water rock only was used as a covering to the bank. Length of dam, 250 feet; of shore protection, 1,350 feet, of which 250 feet is above the dam.

On September 23 Dam No. 3, sheet 28, was begun, and this work, with adjoining shore protection, was finished October 5. It was found necessary to strengthen this work after it had been allowed to settle for a few days. This dam closes a cut-off from Crooked Slough, left bank, near foot of slough. The length of the dam is 100 feet; of shore protection, 1,450 feet, of which 620 feet is above the dam.

Dam No. 4, sheet 28, closing the shallow passage between Islands 152 and 153, was built October 2 and 3. Its length is 175 feet; shore protection, 55 feet.

The head of Island 152 was also protected, the work commencing October 4 and being completed October 20. The bank being high and sandy, the brush was carried well up to the top. The length of this shore protection is 925 feet, of which 125 feet is on the west side.

Dam No. 5, sheet 28, closing cut-off on right bank near foot of Crooked Slough, was begun October 6 and finished on the 22d. The adjoining shore protection is 1,825 feet long, of which 500 feet is below the dam; length of dam, 75 feet.

Shore protection on left bank, at head of Crooked Slough, was begun October 9 and finished on the 22d. Its length is 2,130 feet, the brush being carried only to water surface at time of construction, the remainder of slope being covered with rock.

Shore protection on Island 153, opposite Dam No. 2, sheet 28, was begun October 15, and work ceased October 27. Its length is 990 feet. The shore was high and much obstructed by trees and snags, involving considerable labor in clearing. The rock and brush were carried to a height of about 8 feet above low water, and it is proposed to carry them to the top of the bank at some future time.

On the 27th of October the barges, with the exception of No. 27, were laid up in harbor opposite Heytman's Landing.

During October Mr. W. A. Thompson made a survey of the entire locality, which is now being plotted.

The work at Crooked Slough was undertaken because at the time of its commencement it was, without doubt, more obstruction to navigation than any other locality. The principal feature of the work was the closing of Harper Slough. The closing of this slough would naturally increase the current and volume of water passing through Crooked Slough and doubtless prove destructive to the insecure banks of that slough. On this account considerable shore protection was undertaken and the closing of cut-offs drawing water from and diverting the currents of the slough. It is proposed to extend the shore protection somewhat during the coming season and to strengthen nd repair it where found necessary; and it is hoped, although not fully expected, hat such work will be sufficient for the locality. The existence of two shallow crossngs above Crooked Slough is known and the closing of Harper Slough may favorably ffect them. Should this not prove to be the case it will be proper to close Capoli nd Ferryville Sloughs and a branch above Lansing near the Government light, leavng, however, the Winneshiek, which follows the bluffs on the eastern shore, open.

As regards shore protection, flat slopes were made about 1½ to 1, and the brush in most cases was carried up to the water surface, the remainder of the slope being covred with rock only. It is thought that this method will be more efficacious than he old practice and be cheaper by saving in brush.

Table of quantities, etc.

Designation.	Length.		Rock.	Brush.
	Dam.	Shore protection.		
	Lin. ft.	*Lin. ft.*	*Cub. yds.*	*Cub. yds.*
Sheet 28:				
Dam and shore protection No. 1, Harper Slough	686	355	3,543.7	2,647.3
Dam and shore protection No. 2, Swift Slough	250	1,350	2,784.5	1,484.3
Dam and shore protection No. 3, cut-off left bank	100	1,450	2,389.3	1,131.6
Dam and shore protection No. 4, Island 152 to Island 153	175	55	176.8	251.5
Dam and shore protection No. 5, cut-off right bank	75	1,825	3,248.8	2,061.3
Shore protection head Crooked Slough, left bank		2,130	2,265.5	1,783.4
Shore protection head Island 152		925	940.1	671.6
Shore protection Dam No. 2, right bank		990	1,953.8	863.3
Total	1,286	9,080	17,302.5	10,894.3

EXPENDITURES.

Expense		$759.30
Labor		5,436.49
Fuel		798.08
Subsistence		1,224.73
Material		16,545.93
Total		*24,764.53
Deduct:		
2,129.5 cubic yards brush on hand, at 28 cents	$596.26	
Subsistence on hand	50.00	
1,000 poles on hand, at 2½ cents each	25.00	
		671.26
Net expenditure		*24,093.27

Material put in:		
Rock	cubic yards	17,302.5
Brush	do	10,894.3
Total		28,196.8

Operations in 1887.—An allotment of $20,000 was made for continuing work at this locality in 1887. The work proposed was in continuance of the project of 1886, comprising the construction of about 2,000 linear feet of shore protection in the slough, the closing of several small cut-offs, and, if found expedient, closing dams at Capoli and Ferryville sloughs.

Work in the field was begun on May 26 and closed June 10. The steam-launches *Louise* and *Stella* performed the towing, the remainder of the fleet consisting of building-boat, quarter-boat, grasshopper, and 15 barges.

The work accomplished is as follows: The construction of Dam No. 6, which closes a small slough near head of Crooked Slough, which dam, with continuous shore protection, is 400 feet long; the extension of shore protection at head of Crooked Slough, 265 feet; extension of shore protection opposite Dam No. 2, 510 feet; extension of shore protection above and below Dam No. 2, 1,810 feet; and the raising of Dam No. 5 and repair of shore protection above and below.

---

*General office expenses and deterioration of plant not included.

The amount of material put in the work was: Rock, 4,560 cubic yards; brush, 1,925 cubic yards; at a total cost of $6,549., or an average of $1.01 per cubic yard in place. It is not thought that further work will be needed the present season, as the channel is now in excellent condition.

GUTTENBERG TO WAUPETON.

An allotment of $20,000 was made for work in 1887 in this stretch of river, 16 miles in length. It is proposed to perform the following, or as much of it as can be accomplished with the funds available and may seem advisable at time of construction, viz: Raise the wing-dams at foot of Cassville Slough and the closing dam in chute of Island 192; about 2,000 feet of shore protection in Cassville Slough; closing dams at Jack Oak Slough and Bunker Chute, and about 2,000 linear feet of shore protection on Island 198 and in bend opposite.

The contract for the work was let to Sid. J. Truax, of Hastings, Minn., at $1 per cubic yard for rock and $1 for brush. Operations did not commence until July 1, 1887.

ROCK ISLAND RAPIDS.

Operations in 1886 (*at Duck Creek Chain*).—The act of Congress of August 5, 1886, under head of Improving Mississippi River, from Saint Paul to Des Moines Rapids, contains the following: "Of which amount $6,000, or so much thereof as may be necessary, shall be applied to the removal of the rock at Duck Creek Chain, at Rock Island Rapids."

For the expenditure of the above sum the following project was presented by you:

"The rock in question above the established grade of the rapids improvement lies in scattered patches and can be most advantageously removed by chisel and dredge, or by submarine blasting and dredge, its location, quantity, and depth of cutting not justifying the use of coffer-dams. I would propose to remove as much of the rock as can be disposed of with the sum available by one of the two methods first mentioned, and, to facilitate the work and take advantage of the present favorable season and stage of water, would respectfully ask authority to invite bids by circular at ten days' notice."

* * * * * * *

The project having been approved by the Chief of Engineers, proposals for performing the work were asked by circular.

On October 4, in accordance with his proposal, an agreement was made with A. J. Whitney for the removal of solid rock, at the rate of $7 per cubic yard. Subsequently an arrangement (afterwards approved by the Chief of Engineers) was made with him to dredge up loose rock at $8 per hour, actual working time. The chisel was in operation thirty actual working days, being laid up for winter November 20. The average amount broken was 14.83 cubic yards per day (solid). The dredge was employed in removal of the rock broken by chisel ten days and made an average of 44.48 cubic yards (solid) per day. The dredge was employed on loose rock sixty-eight hours, removing 129.83 cubic yards, at a cost of $4.19 per yard.

SUMMARY.

444.84 solid cubic yards rock by chisel and dredge, $7	$3,113.88
129.83 solid cubic yards rock (loose), at $4.19 (68 hours, at $8 per hour)	543.99
Engineering and contingencies	462.70
Total	4,120.57

Operations in 1887 (*at Campbell's Chain*).—An allotment of $10,000 was made for work in 1887, in removing projecting points of rock and ledges much interfering with navigation, at Saint Louis, Cabin, Campbell's, and Moline Chains, and for continuing operations at Duck Creek Chain. Proposals for performing the work were invited and an agreement was made with A. J. Whitney, of Rock Island, the lowest bidder, for removing rock at $7 per solid cubic yard and $8 per hour for hire of dredging plant. These prices are the same as those paid in 1886. Work was commenced April 9, at Campbell's Chain, with one dredge and one chisel-boat, and was carried on until June 30, with many interruptions from high water, winds, and accidents. At times two chisel-boats were at work. The rock at Campbell's Chain was found to be much harder than was anticipated and progress has been very slow. It is, however, thought that work at this chain can be completed in July and the plant moved to Saint Louis Chain.

Up to the close of the month 296.34 solid cubic yards of rock had been excavated and removed, and the dredge had been employed in removing loose rock from the head of the chain 177½ hours.

Mr. C. H. Beuck was the local inspector.

ANDALUSIA.

An allotment of $3,000 was made in 1887 for repairing the dam at Andalusia Chute nd in building a dam at Vela Chute. This work was accomplished in April, 1887, y hired labor and purchase of rock in open market, the steam-launch *Louise* and a leet of 6 barges being used for moving the material.

Total amount of rock put in the work, 3,411 cubic yards.

BUOYS ON ROCK ISLAND RAPIDS.

On November 1–3, 1886, the buoys were taken in and stored for the winter, all the ranges being carefully examined and verified.

On March 19, 1887, launch *Louise*, with steam-drill boat and small flat, began resetting the buoys, and the work was completed March 31. There were added to the old system of 26 buoys 3 new ones, numbered 9½, 12½, and 17½. The position of No. 10 was changed. All the range stakes were carefully looked up, reset, and changed where necessary, and repainted. The old mooring-chains were found at Nos. 1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, and 22, and new bolts and chains were put in at Nos. 2, 6, 10, 15, 20, 21, 23, 9½, 12½, and 17½. When buoys are carried away by rafts, as sometimes happens, they are reset by Mr. C. H. Beuck, inspector. They have been proved to be of much aid to navigation.

REMOVAL OF WRECKS AT WABASHA AND HASTINGS—THE ROYAL ARCH.

The barge wreck at Wabasha and those of the *Harris* and *Yeatman*, below Hastings, being great obstructions to navigation, were removed by hired dredge in October, 1886, at a cost of $1,048. The *Harris* was a stern-wheel boat 200 feet long and 35 feet beam, sunk in 1864. Her machinery, as also that of the *Yeatman*, had been previously removed. The *Yeatman*, sunk about 1860, was about 150 feet long and 25 feet beam.

The *Royal Arch*, a side-wheel boat about 240 feet long and 40 feet beam, sunk in 1856 about 9 miles below Dubuque, Iowa, was removed by United States dredge *Phœnix* July 7 to 15, 1886. Nearly all of her machinery had been taken off at the time she was sunk. Cost of removal, $474.41.

UNITED STATES DREDGE PHŒNIX.

An allotment of $5,000 was made for 1887 for expenses of dredging in cutting new channels at obstructed points. The dredge *Phœnix*, assisted by tow-boat *J. G. Parke*, was employed on this duty during the month of June, 1887, and succeeded in opening good steam-boat channels at Red Rock, Merrimac, and Frenchman's bars, and at Island No. 17. Amount of material removed during progress of work, 24,953 cubic yards.

SNAG-BOAT GENERAL BARNARD.

No funds being available under special appropriation for operating snag-boat at beginning of year, a small allotment was made from this appropriation for urgent work.

Operations are given under head of improvement of Upper Mississippi River.

Amount expended for snag-boats, $2,836.67.

Very respectfully, your obedient servant,

C. W. Durham,
Assistant Engineer.

Maj. A. Mackenzie,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

United States Engineer Office,
Keokuk, Iowa, July 13, 1887.

Major: I have the honor to make the following annual report for the fiscal year ending June 30, 1887, of work in my charge under appropriation for "Improving Mississippi River from Saint Paul to Des Moines Rapids." These works were as follows: (1) Removing rock from channel of Mississippi River at Drew's Prairie, (2) repairing Shokokon West Dam; (3) repairing Shokokon East Dam; (4) building dam in Vixen Chute; (5) blasting rock below Dallas City; (6) repairing plant.

For the works from 1 to 5, inclusive, mentioned above, there was allotted in March, 1887, under the head of "Building dams and shore protections, removing rock, etc., between Otter Island, Illinois and Nauvoo, Ill."	$30,000.00
Prior to this, from July 1, 1886, to March 1, 1887, there was expended	5,179.86
Total allotment	35,179.86

DREW'S PRAIRIE.

At this place a survey, made in the summer of 1886, developed a patch of bowlders, rock, and clay, measuring about 100 feet by 20 feet, and directly in the path of boats crossing from the mouth of Henderson River to the shoulder of Otter Island. There was, at low water, but 2 feet on this patch, and it was resolved to remove it. United States drill-boat 34 was put to work on it November 1–10, 1886, followed by United States dredge No. 1, November 11 and 12, 1886, and May 24 to June 9, 1887. The work accomplished is as follows, the patch being excavated to 5 feet below low water:

Holes drilled		60
Holes blasted		58
Dynamite used	pounds	110¼
Rock and gravel dredged	yards	365

REPAIRING SHOKOKON WEST DAM.

The two dams in Shokokon Slough had, in the course of four years since their construction, settled to such an extent as to greatly impair their usefulness. At low water there was, for a great portion of the dams, 4 feet of water passing over, which, considering the swiftness of the current at the crest of the dam, made it questionable whether the dams interposed any appreciable obstruction to the flow of water through Shokokon Slough.

October 13, 1886, dredge No. 1, tow-boat No. 3, and launch *Lucia* were put at work making repairs. Dredge No. 1 was employed from October 13 to November 10, 1886, and June 9 to 21, 1887. Piling was driven through the length of the dam at intervals of 5 feet, and against these short plank were laid to break the force of the current, which was so swift as the work progressed that large stone would be swept away but for the plank.

The gravel with which it was attempted to repair this dam was brought from the foot of Burlington Bluffs, about 6 miles distant. It was finally found expedient to use with the gravel a larger proportion of rock, the latter being towed from Nauvoo, a distance of 32 miles. Tow-boat No. 3 made two trips daily and brought 200 cubic yards at a trip, provided she was kept at this work only. The up trip with two barges required five to eight hours, according to the stage of water.

The piling put in was found to be of the greatest service in handling the barges and in holding them in line, besides keeping the rock from washing away as it was put in. November 13, 1886, the fleet was withdrawn and put into winter quarters. At that time the dam was about 6 inches out of water the entire length, with a fall over it of 3.72 feet; the stage of water at Rock Island 3 feet, at Keokuk 3 feet.

In June, 1887, a break occurred near the west end of dam and was filled with 617 cubic yards of rock. At this time there was a head of nearly 6 feet.

The materials used in this work were as follows:

Rock	cubic yards	2,034.93
Gravel	do	2,551.77
Piling	linear feet	1,592.00

RAPAIRING SHOKOKON EAST DAM.

The repairs to this dam were begun May 22, 1887, and finished June 21. There were two gaps in the dam, of 200 and 300 feet, respectively, where the water poured over 6 feet deep. As the repairs were prosecuted, the difference in the level of the water above and below the dam kept increasing until, on June 21, there was a difference of 6.2 feet, certainly the largest fall over any closing-dam along the Upper Mississippi River improvements. At the time this fall was observed the gauge at Keokuk registered 2.6 feet. The effect of the gravel in tightening the dam was very marked. Not the least difficulty was experienced in closing the dam. Mats placed against the piling, driven 6 feet apart, so effectually checked the current that the operations were carried on in what was practically still water.

United States dredge No. 1 worked here from June 9 to 21, the gravel being taken from the bar below Burlington Bluff. A layer of brush 20 feet wide extends clear across he face of the dam and is covered with gravel. The effect of this was to increase the all over the dam from about 4.5 feet to 6.2 feet, in the course of a few days.

The materials used in the repairs are as follows:

Rock	cubic yards..	3,075.28
Brush	do....	707.66
Gravel	do....	2,657.60
Piling	lineal feet..	3,120
Poles	number..	166

VIXEN CHUTE DAM.

This chute, which has been enlarged for the last few years at the expense of the main channel, had, at the beginning of the work, attained the dimensions of 500 feet wide by 12 to 18 feet deep at the site of the dam, with a strong current. Piling was driven across it early in June, and on the 22d the tow-boat *Vixen* and dredge No. 1 were put at work to close the chute.

The dam consists of a row of piling 6 feet apart, below which an apron of brush and rock extends down-stream 35 feet. At the piling loose rocks were thrown in, while, with dump-boats, the upper side of the rock pile was backed with gravel, the intention being to provide a water-tight junction between the dam and the sandy bottom.

When the rock had attained a height of 8 feet above the bottom the gravel was discontinued. The dam is to be finished with brush and stone in the usual manner.

The material account to date is as follows:

Rock	cubic yards..	1,637.36
Brush	do....	911
Gravel	do....	2,972
Piles	lineal feet..	2,233
Poles	number..	166

BLASTING ROCK BELOW DALLAS CITY, ILLINOIS.

The drill-boat was put at work blasting detached bowlders from the vicinity of Pontoosac late in November, 1886. These bowlders had been located by a survey made in the summer of 1886, and some of them were above the surface at low water. They proved to be of the hardest granite and were drilled with difficulty, though they flew all to pieces when blasted. Three holes were drilled and as many bowlders exterminated. Eighteen pounds of dynamite were used. There still remains a number of high rocks to blow up and remove.

The rock for the works enumerated above has been taken from the vicinity of Nauvoo, Ill.

REPAIRING PLANT.

A great number of boats and barges were hauled out, repaired, and calked during the year. Of these repairs, detailed statements have been made monthly and it is not deemed necessary to recite but a few of the leading facts.

Quarter-boats 45 and 46 had complete new hulls put under them, besides painting and renovating; drill-boat 34 was constructed out of the old Rock Island Rapids drill-boat and that belonging to the Des Moines Rapids appropriation, the hull being an old 65-foot barge and the cabin being built mostly out of the cabin of the Des Moines Rapids drill-boat; pile-driver 73 had a complete new set of leaders made, 8 feet higher than the original ones, and was otherwise repaired. More than thirty different boats were worked on, to a greater or less extent.

Very respectfully, your obedient servant,

M. Meigs,
United States Civil Engineer.

Maj. A. Mackenzie,
Corps of Engineers, U. S. A.

Z 4.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

At the beginning of the fiscal year there was on hand a balance of $10,000, but this amount was not available for any work under the approved project for the Des Moines Rapids Improvement, having been allotted by Congress to the construction of a pier below the Des Moines Rapids Canal. The act of Congress approved August 5, 1886, contained an item of $26,250 for the Des Moines Rapids, but of this amount $15,000 was, by the act, allotted to pier construction, leaving but

$11,250 as the actual appropriation for the "improvement of Des Moines Rapids."

The work accomplished during the past year has been the laying of 1,353 square yards of slope wall on the canal embankment, and the placing of 1,313.46 cubic yards of rubble-stone along the foot of the embankment on the river-side. About 600 yards of riprap face stone received during the year remains on hand unlaid.

Stone for this work has been procured from the Sonora Quarries under contract with Patterson Brothers, of Keokuk, Iowa. The abstract of proposals for furnishing stone will be found with report on construction of dry-dock.

The details of the work of the past year will be found in the appended report of Mr. M. Meigs, United States Civil Engineer, under whose supervision the work has been carried out.

The work yet remaining to be done to complete this improvement in accordance with the project, which has received the approval of Congress, is a small amount of blasting and dredging in the channel above Nashville, raising lock-walls 4 feet at lower and middle locks, refilling and completing paving of canal embankment, building sluices for removing sediment, building an office at the lower lock, and completing the lock grounds.

In the construction of the dry-dock at the Des Moines Rapids Canal, the openings for emptying the dock have been made very large, with a view to sluicing through them the muddy water which comes into the canal from Price's Creek during freshets. It is thought that these openings will serve as one of the sluice-ways heretofore projected for assisting in removing mud brought into the canal by the creeks.

There is now available "for pier construction in extending the outer wall of canal to the pivot-pier of bridge" at Keokuk, $25,000; but no work on a pier has been commenced, for the reason that the exact wishes of Congress are not known; and if such were known, the amount on hand is not sufficient to justify the commencement of any pier that will stand in the location proposed. But, under the circumstances, the delay in commencement is not injurious to the interests of navigation, for if any pier such as is designated by the act is to be built it can be completed in one season, and as a partial construction would be injurious rather than beneficial, it appears desirable to delay the work till there are sufficient funds on hand to complete a suitable structure. No detailed plans for such a structure have been officially prepared or presented, and such plans can not well be prepared until the exact wishes of Congress in the matter are known. It is hoped, though, that no further allotments for a permanent pier may be made, it being believed that the same would be an unnecessary expenditure of money. But such action is recommended as will permit the construction of the structure suggested by the War Department; that is, a floating boom. Such a structure will far better serve the interests of navigation, be more easily cared for, and will cost but a fraction of the amount required for a pier. This matter is referred to in Senate Ex. Doc. No. 72, Forty-ninth Congress, second session, where the following legislation is recommended:

> That as much as may be necessary of the $25,000 appropriated in acts of July 5, 1884, and August 5, 1886, for the construction of a pier at the outer wall of the Des Moines Rapids Canal, may be expended in the establishment of a floating boom, connecting said wall with the upper draw-rest of the bridge at Keokuk, if, in the opinion of the Secretary of War, such work would best serve the interests of navigation, and that the remainder, if any, may be used in continuing the improvement of the Des Moines Rapids under present project.

stone and backing, ready to be laid when a new appropriation becomes available, viz:

Cut stone on hand June 30, 1887	cubic yards..	42.16
Backing stone on hand June 30, 1887	do....	127.00

REMOVING ROCK FROM THE CHANNEL ABOVE NASHVILLE, IOWA.

The canal-dredge and tow-boat *Vixen* worked from August 9 to 30, 1886, removing stray rock from the channel above Miller's Run and Montrose; but this work was for taking out isolated rocks, many of which no doubt were brought in by the ice since the channel was originally cleaned out. The expense was charged to the allotment for operating and care of Des Moines Rapids Canal.

The rock removed was small in amount, the dredge having to pick up isolated bowlders and losing, of course, much time in the operation. Part of the time a diver was employed to chain rock that could not be gotten into the dipper. Rock dredged, 209 cubic yards.

The effect of this work is to give a channel from Montrose to Nashville which affords 4½ feet at low water of 1864, a depth 6 inches greater than obtains at the Rock Island Rapids, and sufficient for the present needs of commerce. There is a section of the channel between Nashville Coffer-dams Nos. 1 and 2 which has not yet been excavated and which is from 0.0 to 1 foot above grade; but, as the boats have no difficulty in passing the rapids at present without this excavation, it was thought desirable to leave it to the last.

OFFICE BUILDING.

The necessity for a proper office building has been often stated and is a part of the official approved project for completing the canal. Up to the present time no fund has been available for the purpose, however, and the office is still in embryo.

SLUICES FOR CANAL.

The sluice for discharging the muddy flow of waters of Price's Creek into the river has been built in connection with the dry-dock, so that this part of the project for the canal may be considered accomplished. The extra expense incident to the above work should be credited to the dry-dock and paid by the appropriation for improving Des Moines Rapids.

CONTINGENCIES.

Under item 4 of project approved September 9, 1886, a considerable number of expenditures for repairs are charged, such as repairs to buildings, wheelbarrows, barges, etc. The old pair of horses belonging to the appropriation for improving Des Moines Rapids, and which have been in constant use since 1875, were sold at auction and replaced by a new team at an expense of $300.

DISTRIBUTION OF EXPENDITURES.

Repairs to dredge, new chain	$118.02
Purchase of new horses	300.00
Purchase of new skiff	40.00
Repairs to plant, putting up ice for use of boats, etc	323.42
Purchase of stone	3,052.16
Labor, towing and laying stone	2,099.71
Subsistence of launch, towing stone	80.45
Fuel of launch, towing stone	70.40
Contingent office expenses	551.81
	6,635.97
Retained percentage on stone	339.13
	6,975.10

MATERIAL ACCOUNT.

Rubble-stone received, cubic yards	1,313.46
Rubble-stone put in, cubic yards	1,313.46
Rip rap face stone received, cubic yards	1,098.61
Rip rap face stone laid, cubic yards (approximate)	500.00
Slope wall laid, square yards	1,353.00

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Z 5.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL.

The Des Moines Rapids Canal was open for navigation during the past year 238 days, during which time there passed through it 990 steamboats and 318 barges, carrying 20,797 passengers, 52,815 tons of merchandise, and 366,432 bushels of grain. There also passed through 178,754,876 feet of lumber, 24,827,000 feet of logs, 90,549,922 shingles, and 49,961,781 lath. The traffic of the year as regards rafts of logs and lumber was greatly increased over former years by the low stage of water requiring the use of the canal.

The deposits washed into the canal from adjoining bluffs has, as heretofore, been a continual source of trouble, and during a portion of the year it was necessary to keep a dredge at work day and night to prevent an interruption of traffic. Seventy-eight thousand five hundred and thirty-seven cubic yards of material were dredged during the year.

For some time back the removal of material has hardly kept pace with the filling, but it is intended during the coming season to materially increase the amount of dredging. When the necessity for this excessive amount of dredging is done away with, which result it is expected will be accomplished by sluices to be built in connection with improving Des Moines Rapids, the expenses of operating the canal can be materially reduced.

During the past year electric lights were put on dredge, for night work, and at the middle lock. All the locks are now provided with electric lights, and passage of the canal is made much easier thereby, especially for rafts.

The four cribs located above the guard-lock have proved of great assistance to boats entering the canal from above, and it is proposed, during coming season, to still further facilitate entrance by placing in front of the piers a floating boom.

The gates of the canal are getting old, and extensive repairs are needed. Such repairs were to have been carried out during the past year, but circumstances did not permit. They will be made next winter.

The operating and care of the canal are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report, giving the operations of the year in detail, is appended.

Tables are given with this report which show: (1) Expenditures for fiscal year ending June 30, 1887; (2) comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877; (3) comparative expenditures for operating and care Des Moines Rapids Canal for fiscal years 1882 to 1887.

The expenses of operating and care are now provided for by an indefinite appropriation made by act of March 3, 1881.

The original estimate for operating and care was $40,000 per annum, and with all parts of the canal in good condition the expenses can be reduced considerably below this amount. But so long as the item of dredging remains as large as at present, and when it is necessary to replace worn-out parts or appliances, the expenses will be necessarily increased beyond the original estimate.

The approved project for the fiscal year ending June 30, 1888, is as follows:

Office and general administration:		
Salaries	$5,000	
Supplies	250	
Miscellaneous	250	
		$5,500

Canal and locks:		
Labor	$18,000	
Supplies	2,000	
Current repairs	4,000	
		$24,000
Dredging canal:		
Labor	8,000	
Supplies	3,500	
Current repairs	4,000	
		15,500
Boom at head of canal		2,200
		47,200

ABSTRACT OF APPROPRIATIONS.

By act approved April 30, 1878	$7,500
By act approved June 18, 1878 [allotment]	32,500
By act approved March 3, 1879	40,000
By act approved June 14, 1880	30,000
By act approved March 3, 1881, for fiscal year ending June 30, 1882	45,000
By act approved March 3, 1881, for fiscal year ending June 30, 1883	75,000
By act approved March 3, 1881, for fiscal year ending June 30, 1884	47,000
By act approved March 3, 1881, for fiscal year ending June 30, 1885	40,500
By act approved March 3, 1881, for fiscal year ending June 30, 1886	43,000
By act approved March 3, 1881, for fiscal year ending June 30, 1887	44,000
Total	404,500

Money statement.

Amount available on approved project for fiscal year ending June 30, 1887	$45,000.00
July 1, 1886, balance on hand	2.59
June 30, 1887, amount drawn from Treasury under indefinite appropriation	44,000.00
	44,002.59
June 30, 1887, amount expended during fiscal year	42,152.84
June 30, 1887, balance on hand	1,849.75
July 1, 1887, amount available under indefinite appropriation on approved project for fiscal year ending June 30, 1888	47,200.00

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1887.

Month.	Office and general administration.				Canal and locks.				Dredging canal.				Grand total.
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.	Labor.	Supplies.	Current repairs.	Total.	
1886.													
July	$375.00	$3.75	$20.00	$398.75	$1,797.00	$130.98	$422.11	$2,350.09	$889.35	$574.03	$161.42	$1,624.80	$4,378.64
August	375.00	43.02	1.50	419.52	1,722.50	391.32	628.22	2,742.04	1,010.14	757.34	48.56	1,816.04	4,977.60
September	625.00	....	84.62	709.62	1,992.80	496.41	98.11	2,587.32	973.05	596.03	117.22	1,686.30	4,983.24
October	375.00	9.80	....	384.80	1,593.74	244.44	89.76	1,927.94	746.20	396.27	96.81	1,239.28	3,552.02
November	375.00	1.50	....	376.50	1,447.67	84.20	309.26	1,841.13	48.33	68.50	61.11	177.94	2,395.57
December	375.00	....	164.12	539.12	1,423.33	275.90	1,036.83	2,736.06	....	....	28.52	28.52	3,303.70
1887.													
January	375.00	....	....	375.00	1,323.00	....	345.36	1,668.36	....	....	16.04	16.04	2,059.40
February	375.00	1.75	4.75	381.50	1,360.00	20.25	213.67	1,593.92	....	....	67.91	67.91	2,043.33
March	375.00	1.25	19.09	395.34	1,616.02	108.30	206.22	1,930.54	118.58	115.52	396.69	630.79	2,956.67
April	375.00	22.12	120.50	517.62	1,418.50	168.00	180.88	1,767.38	1,226.60	167.65	741.63	2,135.88	4,420.88
May	375.00	....	6.25	381.25	1,418.17	660.02	112.96	2,191.15	1,137.20	1,042.44	707.83	2,887.47	5,459.87
June	....	2.00	3.65	5.65	1,213.50	172.98	132.21	1,518.69	....	92.34	10.24	102.58	1,626.92
Total	4,375.00	85.19	424.48	4,884.67	18,826.23	2,752.80	3,775.59	24,854.62	6,149.45	3,810.12	2,453.98	12,413.55	42,152.84

Comparative traffic statement, showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years, ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Logs.	Lumber.	Laths.	Shingles.	Lockage at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1878	670	548	....	53,346	737,415	....	25,000,000	4,000,000	3,700,000	824
1879	802	454	5,008	64,658	2,192,642	8,086,000	33,347,612	8,721,796	11,749,000	1,564
1880	967	651	13,231	78,989	2,197,469	18,160,960	21,832,478	27,863,640	30,561,000	2,497
1881	840	276	10,008	44,962	1,154,092	11,013,410	52,256,235	11,657,655	15,091,000	1,339
1882	760	444	8,588	29,042	781,817	4,475,000	17,150,011	3,112,825	4,885,250	2,292
1883	1,107	705	9,192	43,859	729,174	1,040,000	13,093,325	11,558,000	4,485,000	1,353
1884	913	245	13,057	54,215	470,580	9,399,764	57,018,151	15,924,645	25,182,250	1,908
1885	889	169	13,065	54,120	776,432	2,779,670	43,119,797	13,473,205	25,018,750	1,270
1886	784	218	22,221	56,001	465,681	3,105,360	22,769,823	4,302,800	8,253,000	755
1887	990	318	20,797	52,815	366,432	24,627,000	178,754,876	49,961,781	90,450,922	1,717

Comparative expenditures for operating and care of Des Moines Rapids Canal for fiscal years 1882 to 1887.

Years.	Office and administration.				Canal and locks.				Dredging canal.					Machine-shop.	Grand total.
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.	Labor.	Supplies.	Repairs.	Contract.	Total.	Total.	
1882	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79	$2,340.43	$572.09	$846.58	$14,080.39	$17,839.49	$68.75	$47,053.34
1883	4,821.12	289.86	449.52	5,560.50	25,813.40	2,216.87	3,203.01	31,233.28	4,765.93	1,538.80	598.04	30,666.17	37,568.94	3,564.07	77,926.79
1884	5,045.22	209.12	665.62	5,919.96	17,654.23	4,344.51	1,291.20	23,289.94	7,485.45	4,789.32	1,262.02	....	13,536.79	536.73	43,283.42
1885	5,015.00	245.31	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77	3,353.12	*8,580.69	1,888.73	....	*13,822.54	....	*44,506.50
1886	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86	4,984.55	3,017.49	3,530.41	....	11,532.45	....	43,009.58
1887	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62	6,149.45	3,810.12	2,453.98	....	12,413.55	....	42,152.84

* Includes $5,700 paid for four new dump-boats and $102 paid for hire of one dump-boat. These amounts, in all $5,802, were outstanding June 30, 1884, but not included in detailed statement for that year.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 19, 1887.

MAJOR: I have the honor to submit the following report on operating and care of Des Moines Rapids Canal, Mississippi River, for the fiscal year ending June 30, 1887:

The canal was open for navigation two hundred and thirty-eight days and closed one hundred and twenty-seven days. The water during the past year has, as a rule, been very low, and but little damage has ensued from high water. The highest stage of water at the lower lock during the year was 13.8 feet, on February 11, 1887, and the lowest water was 1 foot, on August 22, 1886. The canal was closed November 24, 1886, and opened March 28, 1887.

The guard-lock gates stood open one hundred and seventy-three days.

A Brush electric light plant has been added to the equipment of the middle lock. The engine and counter-shaft were built during the winter at the Des Moines Rapids shops at the lower lock by the regular employés of the canal. The effect of the electric-light installations at all the locks has been good. The expense of running these lights is nominal, as steam is necessarily kept up at each lock. The lamps are lit only when a boat or raft is passing, or when the lock hands need the light for repairs. Since the application of the electric light it has become the usual thing for rafts to work through the canal at night without interruption, while in former times this was rarely attempted, and it is no uncommon thing now for rafts to come over the rapids above the canal at night and enter the guard-lock, a thing unheard of before the electric light was applied to the lock. It is found that when a boat is approaching the lock and is itself unprovided with electric lamp and reflector, the best effect is produced by lighting the lamps only when the boat is close to the lock. The glare from the lamps is otherwise apt to blind the pilot. In addition to the good effect of the light on navigation through the locks, it may be mentioned that to the lock-men themselves the light is of the utmost assistance in performing their duties, and in case of repairs being needed at night the light is invaluable. The two Weston two-light dynamos in use at the guard and lower locks have given satisfaction. The Brush light at the middle lock seems also to be an excellent machine, but our experience with that is at present much shorter than with the other two. The lamps are applied on cranes, secured to the top of the iron-gate columns. A lamp is placed at each end of the lock on opposite sides of the canal. These two lamps, of 3,000 candle-power nominally, give all the illumination necessary.

REPAIRING CANAL EMBANKMENT.

Very few repairs were found necessary on the canal embankment during the past year. In October, 1886, a small leak was repaired in the vicinity of the dry-dock, requiring about two days' work of six men.

DREDGING THE CANAL.

The canal-dredge and tow-boat *Vixen* worked one hundred and thirty-nine days, from July 1, 1886, to October 21, 1886, and from April 1 to May 21, 1887. The thorough overhauling given the hull and machinery of dredge during the winter of 1886 has made her a very effective machine. In view of the great arrears of dredging, electric lights were applied to the dredge and tow-boat, and they were worked night and day. The electric apparatus on dredge consists of a 4,000 candle-power Brush dynamo and two lamps, one on each side of the boat, to be lighted alternately, as desired. A similar dynamo and focusing lamp were placed on the tow-boat. It was found that with these electric lights the work of dredging in the canal could be carried forward as well in the night as by day. In fact, the records show a little more work done at night than by day. There was, of course, while breaking a new crew in, more or less delay incident to inexperience of the men, but after the first two weeks the capacity and output of the dredge were exactly doubled. In case of emergency, therefore, when the canal, as sometimes happens, is nearly closed by the deposit resulting from sudden floods coming down the creeks entering the canal, the electric light gives us the means of removing the deposit in half the ordinary time.

During the past year the following amounts were dredged and removed from the canal:

At Rickey's Point	cubic yards	5,449
At Sandusky	do	45,060
At Price's Creek	do	8,759
Below guard-lock	do	16,923
In guard-lock	do	496
Above guard-lock	do	1,850
Total		78,537

The monthly work of the dredge has been as follows:

Month.	Time employed.	Dredged.
	Days.	*Cu. yds.*
1886.		
July	25	14,788
August	9	4,053
September	26	13,018
October	18	10,647
1887.		
April	26	16,074
May	18	19,957
Total		78,537

During August, 1886, the dredge and tow-boat worked three weeks in the channel above Nashville, removing stray rocks lodged in the channel, and which the extraordinary low water made it easy to find. Much of this rock was no doubt brought in by the ice and its removal was deemed a fair charge against the allotment for operating the canal.

The annual report of 1884 contained an estimate of $33,500 for building sluices at Price's and Lamallee's creeks to draw off the muddy water of these streams and thus lighten the burden of dredging required to be done.

REPAIRS TO FLAT-BOATS, ETC.

The usual current repairs to flats and dumps have been made from time to time as required. The canal plant of dredge and flat-boats is at present in good order, though the dump-boats are begining to show signs of age and hard work.

BOUNDARIES TO CANAL PROPERTY.

Nothing further has been done under this head during the past year. It is intended as soon as a little time is found, to put in monuments at the corners of property.

REPAIRS TO LOCK MACHINERY.

During the fall of 1886 a large lot of oak lumber for repairs of the lock-gates was purchased. When the winter set in the water was low, and it was expected we could complete before spring the repairs on the lower gates, which most needed attention. A sudden thaw and subsequent ice-gorge made temporary repairs only possible, the water staying too high for the work to be done as thoroughly as was contemplated. Sufficient was accomplished to make the gate safe. Considerable repairs will be needed on all the gates of the canal, and will be given them when the opportunity offers.

MACHINE-SHOPS AT THE LOWER LOCK.

During the winter months four lock engineers and two carpenters belonging to the lock force were kept steadily at work, overhauling and repairing machinery belonging to the canal and to the boats of the fleet owned by the United States and laid up in the canal for the winter.

Three electric-light engines were built complete and three plants set up—one at the middle lock, one on dredge No. 1, and one on tow-boat *Vixen*.

OFFICE BUILDING.

The last annual report mentioned the necessity for an office building on the lower-lock grounds for the accommodation and safe-keeping of the canal records. The present inconvenient office costs $240 per year, which, capitalized, amounts to $6,000. It is estimated that a suitable building for the canal can be erected for $5,000.

BUSINESS OF THE CANAL.

Owing to the low water prevailing during the last and present seasons, the canal-traffic statement shows a marked advance over previous years in some respects. Lumber, for instance, is three and a half times as great in amount as in any previous year.

Low water, while it caused a great part of the lumber to be brought through the canal, interfered greatly with the freighting business, the water being too low for the boats to carry much.

CRIBS ABOVE GUARD-LOCK.

The cribs erected above the guard-lock entrance have been found to serve an excellent purpose; but experience shows that there should be a continuous boom placed against them, so that boats forced against the piers by the strong current should not catch on the corner of the piers to the mutual injury of boat and piers. Authority has been obtained for the construction of such a boom 226 feet long, 3 feet deep, and 6 feet wide, to cost not over $2,200. This boom will be constructed as soon as possible.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Traffic statement of the Des Moines Rapids Canal for the year ending June 30, 1887.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Lath.	Lockage.
1886.					*Tons.*	*Bush.*	*Feet.*	*Feet.*	*Number.*	*Number.*	*No.*
July	99	73	56	7,489	9,569	31,285	17,518,903	2,170,000	10,622,000	6,076,020	231
August	59	61	87	4,057	3,709	22,930	29,350,094	1,550,000	22,154,000	9,707,210	232
September	62	63	41	1,928	8,482	15,984	43,532,571	4,917,000	23,649,000	13,869,860	327
October	77	62	40	1,035	4,744	53,858	28,573,952	4,200,000	14,837,422	7,476,891	236
November	36	28	19	131	3,182	56,562	20,667,284	900,000	3,887,500	3,279,450	133
1887.											
March	4	7	4	......	......	......	......	800,000	......	......	16
April	48	23	84	466	8,631	8,994	......	......	......	......	52
May	26	28	42	2,695	11,509	100,520	......	......	......	......	123
June	81	83	45	2,996	7,989	76,299	39,116,982	10,290,000	15,313,000	9,552,350	367
Total	562	428	318	20,797	52,815	366,432	178,754,876	24,827,000	90,459,922	49,961,781	1717

Table showing the amount of material removed from Des Moines Rapids Canal from June 30, 1878, to June 30, 1887.

Fiscal years.	Removed by United States dredges.	Removed by teams.	Removed by contract.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
1879	8,700	......	......	8,700
1880	26,496	1,288	11,553	39,337
1881	9,003	......	......	9,003
1882	18,031	......	49,758	67,789
1883	22,717	......	90,858	113,575
1884	52,616	......	......	52,616
1885	38,097	......	......	38,097
1886	65,970	......	......	65,970
1887	78,537	......	......	78,537
Total	320,167	1,288	152,169	473,624

In addition to the above there has been removed from the head of the channel at Montrose:

For the fiscal year ending June 30—

1883	cubic yards	16,643
1884	do	25,315
1885	do	6,007
Total		47,965

Z 6.

DRY-DOCK AT DES MOINES RAPIDS CANAL, MISSISSIPPI RIVER.

A history of this work is given in my last annual report.

During the past year the masonry walls at entrance to dock have been well advanced. All masonry work will be completed this season and probably a sufficient balance will remain to build and put in entrance and sluice gates.

A detailed account of work accomplished and present condition is given in the appended report of Mr. M. Meigs, United States civil engineer, under whose supervision the dry-dock is being constructed.

In the construction of the dry-dock the discharge openings have been made much larger than originally planned and required for dock purposes, with a view to their use in connection with sluicing muddy water brought into the canal by Price's Creek. If by this work the necessity for a sluice in the canal wall, as heretofore proposed, is done away with, it would seem proper that a sufficient amount be transferred from the appropriation for improving Des Moines Rapids to that for dry-dock, to repay the latter for the extra expense incurred in enlarging sluices. If the results are as anticipated, this question will again be presented in a more definite form.

There has been appropriated for this work $108,750, and there remains to be appropriated to fill original estimate $16,250. Economical construction requires that this amount be given in one appropriation.

The large plant owned by the United States and used in connection with the improvement of the Upper Mississippi will make use of this dock, and the longer its completion is delayed the greater will be the expenses attending the repairing and keeping of this fleet in proper condition. The dock will also be of great benefit to the entire commerce of the Upper Mississippi.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$30,000
By act approved July 5, 1884	30,000
By act approved August 5, 1886	48,750
Total	108,750

Money statement.

Amount appropriated by act approved August 5, 1886		$48,750.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$20,354.70	
July 1, 1887, outstanding liabilities	773.54	
		21,128.24
July 1, 1887, amount available		27,621.76
Amount (estimated) required for completion of existing project		16,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		16,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m., October 19, 1886, for furnishing stone for use at the Des Moines Rapids Canal and Dry-Dock, and delivering the same on United States barges in canal or in the river within five (5) *miles of the head of the canal, or one* (1) *mile of its foot.*

No.	Name and address of bidder.	1,000 cubic yards face stone.	1,000 cubic yards backing stone.	2,000 cubic yards riprap face stone.	1,000 cubic yards rubble filling.	Total.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	
1	Patterson Bros., Keokuk, Iowa*	$10.00	$6.00	$2.25	$0.70	$21,200

* Accepted.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., at 2 p. m., April 15, 1887, for furnishing hydraulic cement for use in construction of dry-dock at Des Moines Rapids Canal.

No.	Name and address of bidder.	Cement, natural, 1,000 barrels, per barrel of 300 pounds.		Cement, Portland, 20 barrels, per barrel.
		In barrels.	In bags.	
1	James McNamara, Keokuk, Iowa	*$1.45	*$1.25	$3.75
2	Meacham & Wright, Chicago, Ill.†	‡1.33	‡1.03	

* Louisville or Milwaukee. † Delivery in bags accepted. ‡ Utica.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 18, 1887.

MAJOR: I have the honor to submit the following report of work done on the United States dry-dock at the Des Moines Rapids Canal for the fiscal year ending June 30, 1887.

The work was suspended from August 30, 1885, to October 1, 1886. On October 22, 1886, a contract was let to Patterson Brothers, of Keokuk, Iowa, for furnishing face stone and backing stone, and slope-wall stone to complete the masonry of the dock.

The work accomplished up to June 30, 1887, consists in excavating for foundations and erecting part of the masonry walls of the entrance to the dry-dock. These latter are now so far advanced that it is probable the present appropriation will suffice to complete them, with possibly enough left to put in the entrance-gates and sluice-gates.

As mentioned in the report on improving Des Moines Rapids, the plan of the dry-dock is such as to combine the sluice planned for drawing off the flood waters of Price's Creek with the dry-dock itself, and it seems but just that the extra expense incident thereto should be borne by the appropriation for improving Des Moines Rapids.

I estimate the extra expense at $12,000. It includes a breast wall and sluices into the river, that might have been built in a much less expensive form, together with culvert and openings into the canal.

Should the appropriation for the dry-dock be in the future inadequate for its completion, this debit should be used to put the dock in condition for use.

The long suspension of work had the usual disadvantageous effect. Several of the derricks employed in the stone yard became so debilitated during their idleness that they gave way under the strain put on them when operations were resumed, and fell. Several narrow escapes were the consequence, but there were no fatalities to record.

The present status of the dry-dock is as follows: Embankment finished. All slope wall laid on outside, with the exception of a very small piece near the sluice. Most of the slope wall laid on the inside of dock. Breast wall and sluice walls finished except top courses. East recess walls and culvert completed to three courses from the top. One-half the main wall [breast] and half of the miter sill completed except coping.

There remains the west recess wall, half the breast wall, and miter sill to build, when the dock will be ready for the gates.

A contract for 1,000 barrels of cement was let to Meacham & Wright, agents of the Utica Cement Company, dated April 21, 1887.

The following shows the amount of stone received, cut, and laid, and amounts excavated for foundations:

Stone received:		
Face	cubic yards..	$509.31
Backing	do....	322.75
Riprap face	do....	222.14
Stone cut, face	do....	471.32
Stone laid:		
Masonry	do....	580.36
Riprap face	do....	726.00
Earth excavated	do....	8,165.00
Rock excavated	do....	652.00

The following is an itemized statement of expenditure:

Purchase of stone		$6,776.47
Purchase of cement		363.45
Purchase of tools and lumber		236.45
Cutting stone		2,753.77
Laying stone		3,275.50
Excavation for foundations		2,828.10
Bailing and draining		721.25
Towing stone		616.36
Overseer at works and miscellaneous expenses not enumerated		1,035.41
Superintendence and office expenses		1,575.94
		20,182.70
Retained percentage on stone	$752.93	
Retaining percentage on cement	20.60	
		773.53
		20,956.23

Very respectfully, your obedient servant,

M. Meigs,
United States Civil Engineer.

Maj. A. Mackenzie,
Corps of Engineers, U. S. A.

Z 7.

REMOVAL OF BAR IN MISSISSIPPI RIVER OPPOSITE DUBUQUE, IOWA.

At the beginning of the fiscal year dredging was in progress along the levee front. This work was finished July 7, 1886, 3,069 cubic yards of material being removed during the week. In May, 1887, an old wreck was removed from the Dubuque Landing and 1,608 cubic yards of sand and rock were dredged from the bar which interferes with a free use of the levee at East Dubuque.

The appropriation for this work is now exhausted, and as all the work contemplated by the existing project has been completed, no further appropriation is asked for. It is probable that any additional work, if such becomes necessary in the future, can be provided for from the general appropriations.

I would submit the following as a final report on this work:

In the years 1844–'45–'52 there was appropriated, under various titles, the sum of $29,500 for work in Dubuque Harbor, but such work has no connection with the work commenced under this title of appropriation in 1877.

Under instructions from the Chief of Engineers and an allowance of $200 from appropriation for examinations and surveys on Western and Northwestern rivers, an examination of Dubuque Harbor was made, under Colonel Macomb's direction, in January, 1876. The condition of affairs at that time is shown in the following extract from the report of Assistant Engineer C. W. Durham, dated February 1, 1876:

* * * * * * *

From the above, from examination of old maps, and from the present survey, it appears that some twenty years ago, and prior to that time, the main steamboat channel ran along the west bank of the river, so that boats could effect a landing at all stages of the river along the entire city front from Seventh street slough to the elevator. Boats and rafts also made use of the channel through Lake Peosta, and landed at what is now called the Old Landing. Since that time a bar has been gradually forming, beginning at the mouth of Seventh street slough and enveloping the entire city front, leaving only a very narrow channel between its lower end and the lower part of the levee. Until the last few years boats were able to work up to the lower levee, passing around the foot of the bar, and making a wide circuit if coming down the river. The opening being so narrow that boats could not turn, they were obliged to back out nearly a half mile, a difficult and tedious proceeding, especially if encumbered by barges, as is generally the case. During the past season even this narrow channel was so obstructed that boats were unable to reach their landings, and our soundings now show a width of deep water-way of only about 150 feet, and even this passage, narrow as it is, would be blocked at low water to steamers drawing 4½ feet of water and over. Of course, when several boats are at the levee at the same time, the difficulties are aggravated, and the necessary wharf-boats still further limit the available space.

The ferry-boat plying between Dubuque and Dunleith experiences great difficulty every season in getting over or around the bar.

A comparison of the soundings taken by General Warren in 1866 with those made by me clearly shows that the bar is gradually closing in upon the shore at the lower levee so that in a few years, unless something be done to avert the calamity, Dubuque will be entirely inaccessible to steamboats at low or even medium stages of the river. Rafts have been unable for years to effect a landing at Dubuque at low stages, and the lumber interest, which is a very large one, cries for relief.

The causes which have led to the formation of this bar and the gradual closing up of the narrow passage, before indicated, clearly appear. Some twenty years ago all the water passing through Lake Peosta, the two inlets of which are shown in the sketch, passed out into the main river through Waple's Cut, and the current from this passage kept the lower levee free from obstruction, nor was there at that time any impediment to the landing at the upper levee between what is now called Seventh-street Slough and Waple's Cut. In the winter of 1858–'59 two lateral breaks occurred, one at Seventh street and the other somewhat lower down, and called the New Barney Cut. The current from these two breaks, which now diverts by far the greater portion of the water passing through Lake Peosta, meeting that of the main river nearly at right angles, has caused the formation of a sand-bar enveloping the entire city front. The extension of Third street still further limited the amount of water passing through Waple's Cut so that this outlet, formerly navigable to steam-boats and offering a safe winter harbor, is now almost entirely filled up.

The plan recommended and presented in March, 1876, by Colonel Macomb, contemplated the construction of dams closing Seventh-street Slough and New Barney Cut and the formation of a current along the city wharf. The estimated cost of necessary work was $32,000.

An appropriation of $15,000 was made by act of Congress approved August 14, 1876. The insufficiency of the appropriation and the development of local circumstances which rendered it inexpedient to close the Seventh-street Slough led to a change of plans, and in June, 1877, a new project was prepared which contemplated the removal of the bar by dredging and the construction of a training-wall, which it was thought would prevent the formation of an eddy and the deposit of sand. The estimate for this work was $40,300. The dredging work was carried out under formal contract with George Williams, of Keokuk, Iowa, during the year 1878, 39,261 cubic yards being removed. The contract price was 27 cents per cubic yard.

An additional $10,000 was appropriated for this work by act of Congress approved June 18, 1878, and under date of July 2, 1878, Major Farquhar submitted a new project which omitted the training-wall and contemplated dredging only. The cost of this dredging was placed at $40,238.40. The $10,000 was expended during the year 1879 for dredging under formal contract with Archibald McArthur, the price paid being 25 cents per cubic yard. Thirty-seven thousand and forty-two cubic yards were removed.

The plans of the work being carried out not being fully satisfactory to some of the citizens of Dubuque, and protests being entered through their representatives, a board of engineers was constituted in May, 1879. After fully considering all the questions relating to the improvement of the harbor of Dubuque, the board submitted a report, which is given in the Report of the Chief of Engineers for the year 1879, page 1141 and following. The following extract gives the conclusions of the board:

* * * * * * *

> The following plan is proposed for the permanent improvement of the harbor:
>
> To prevent the reforming of the bar it is proposed to diminish the present low-water cross-section of the river at the landing by constructing two low spur-dams on the Dunleith shore, as shown on the tracing hereto attached, rising only a foot above low water and extending out to the 3-foot curve at low water, or further, if found necessary. The effect of these spurs on the opposite shore should be carefully watched, and no more contraction should be produced than is necessary to secure the desired effect. The cost of the spurs is estimated at $12,668; but as the dredging already nearly completed has secured easy access to the landing, and as for two years the dredged space has shown little or no tendency to fill up, although, indeed, there have been no marked high-water periods in this time, it is not proposed to begin construction until the present dredged area shows signs of filling up, when the work should be done without delay.
>
> The construction of the spurs will force the current against the bar and Dubuque shore, but the shore below the bar is already protected by stone, either loose or in paving; hence any serious cutting of it is not anticipated. The spurs may cause a slight shoaling at the Dunleith Ferry Landing, but the cost, should it be necessary, of a short causeway 200 to 300 feet in length to the new shore-line would be very small. As the bar is now so far removed as to meet the present requirements of commerce, it is proposed to discontinue dredging, and the available appropriation can be retained to commence the proposed spurs. In case there should be no filling up in the next high water, the dredging should be continued in accordance with the recommendation of Maj. F. U. Farquhar, in his report of July 2, 1878.

* * * * * * *

Examinations made in August, 1879, and subsequently, indicated that but little shoaling was taking place over dredged area, and in consequence projects were presented and approved for continuing dredging under appropriations of 1879, 1880, and 1881, amounting in all to $16,000. The work in 1880 was carried on under agreement with H. S. Brown, who removed 19,573 cubic yards, for which he was paid 17 cents per cubic yard. In 1882, Whitney & Son removed by agreement 3,570 cubic yards, for 25 cents per cubic yard; and in 1884, by agreement with B. E. Linehan, 23,436 cubic yards were removed for 12 cents per cubic yard.

The work accomplished is the removal of the bar which formerly obstructed the Dubuque Landing, and the giving of some relief on the east side of the river opposite Dubuque. There has been removed in all 165,527 cubic yards of material and one wreck, at a total cost of $41,000.

Adding to the actual amounts paid for work and superintendence, the cost of surveys and examinations, we may deduce the following as the cost of the different methods of work:

76,303 cubic yards were removed by formal contract at a cost of.........	$25,004.24
46,579 cubic yards were removed by agreement at a cost of	8,718.84
42,645 cubic yards were removed by Government dredge at a cost of	*7,276.92

---

* This figure includes cost of removing the wreck of the old ferry-boat *A. L. Gregoire*, and the moving of plant from Keokuk, Iowa, and returning tow-boat.

ABSTRACT OF APPROPRIATIONS.

By act approved August 14, 1876	$15,000
By act approved June 18, 1878	10,000
By act approved March 3, 1879	4,000
By act approved June 14, 1880	7,000
By act approved March 3, 1881	5,000
Total	41,000

Money statement.

July 1, 1886, amount available	$1,859.31
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,859.31

Z 8.

ICE HARBOR AT DUBUQUE, IOWA.

A full description and history of this work have been given in previous reports.

During the past year no work has been carried out or expenditures made.

The most important work of that included in the construction of the Dubuque ice or winter harbor is the dredging over a sufficient area to accommodate such boats as wish to take advantage of this favorable harbor. Work already carried out furnishes a depth of at least 6 feet at low water over an area of about 520,000 square feet. The north, west, and south sides of the harbor are left in an unfinished condition, but such condition does not materially interfere with the legitimate use of the harbor.

There remains available for this work a balance of $4,503.99, which, in accordance with the approved project, should be used for riprapping a portion, at least, of the sides of the harbor. This work has not yet been carried out, owing to a slight variance in the plans as proposed by the United States and as desired by the city. During the past year the property lying on both sides of Third street and north of the harbor has passed into the possession of the Chicago, Burlington and Northern Railroad, who are filling, laying tracks, and preparing depot grounds and yards. It may be as well to defer any further consideration of this work till the full intentions of the railroad company are known.

The balance now available will probably complete this work as originally projected; but an item in the last river and harbor act provides that "the unexpended balance, or so much thereof as shall be necessary, shall be applied to paving instead of riprapping said harbor," and if it is the desire of Congress that all the slopes of the harbor be paved, additional appropriations will be necessary. The intention of Congress in the matter not being sufficiently understood to permit of preparing new plans and projects, no new estimates are submitted. While the paving work referred to is not an absolute necessity so far as the practical use of the harbor for legitimate purposes is concerned, it is a very desirable and a proper method of completing the work, if money is available for such a purpose; provided that the slopes given to the sides of the harbor remain as originally planned rather than as contemplated by the plans of the city, which would convert the ice-harbor into one to be used for the purposes of loading and discharging cargoes.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$20,000
By act approved July 5, 1884	20,000
Total	40,000

Money statement.

July 1, 1886, amount available	$4,503.99
July 1, 1887, amount available	4,503.99

Z 9.

HARBORS OF REFUGE ON LAKE PEPIN, AT LAKE CITY, MINNESOTA.

A survey for harbors of refuge on Lake Pepin, called for by act of Congress, was made in 1881, and certain plans and estimates were presented.

The act of Congress passed August 2, 1882, appropriated $10,000 for work at Lake City. The amount was not sufficient to justify commencing work.

By act of Congress of July 5, 1884, $15,000 additional was appropriated, but even this amount did not appear to justify a commencement under original plans. The act of August 5, 1886, added $10,000 to the amount available, giving in all $35,000.

The various sums granted appearing to indicate that a less expensive structure than that originally planned was desired by Congress, new plans were prepared and new projects for commencing work were submitted in July and August, 1886, from which projects the following quotations were taken:

> The original line selected for a breakwater was to the west of the gravel point in front of Lake City. A change of conditions now makes it desirable to locate this breakwater to the east of the point, as shown in red on the accompanying tracing. A breakwater so located and of sufficient length will protect the boat landings, elevator, warehouses, and principal landing of Lake City from eastern storms, and furnish a harbor subject only to the occasional storms coming across the lake. The location proposed is now accepted as the most desirable by the river and local interests.
>
> The original plan for breakwater was continuous timber crib-work, filled with stone (as used on Great Lakes). But the expenses of such work are so great that, if the original plan be followed, the construction permitted by available appropriations would not be of sufficient length to be of any special benefit. It is therefore desirable to so change plans as to materially reduce the cost of the work. By this change weight and strength are necessarily somewhat reduced; but it is believed from experience gained at Stockholm (on the opposite side of the lake) that cribs of logs and superstructure of logs or timber, filled with stone, brush, gravel, and slabs, can be built with sufficient strength to resist the most severe test to which the pier will ever be subjected; that is, crushing and overturning effect of ice. A tracing showing profile of lake bottom on proposed line of breakwater, with approximate location of cribs, is inclosed.
>
> To properly protect the various landings this pier should be about 800 feet long, but owing to excessive depth of water it is hardly probable that so much can be constructed if crib-work rests on present bottom of lake. I would propose to effect some saving of expense by building up in the deep water a foundation of brush, slabs, or gravel to as great a height as safety and circumstances will permit.

In the fall of 1886 some preparations were made for commencing work, but in consequence of strong protests from some of the people of Lake City as to the location operations were suspended. Later the different opinions were reconciled, and, by the voice of the city council, the Government was asked to locate the work where it thought best.

On the 23d of May, 1887, a dredging outfit was sent to Lake City and the construction of a gravel foundation for pier commenced. The natural depth on a large portion of the line of the proposed pier is nearly 30 feet at low water, with a range of 16 feet. It is proposed to reduce this depth, if possible, to less than 10 feet. The work thus far carried out has been very successful, and it is believed that this gravel foundation will so reduce the cost of the work as to permit, with funds available, a sufficient length of dam to give all the relief now required by the interests of navigation.

The plan now being considered for superstructure of crib-work contemplates sloping sides, which will receive the thrust of the ice to better advantage, and the use of 6 by 12 inch timber for the sides, reducing the cost of framing and giving more regular work.

It is proposed to complete the work this season, and, as possibly all the needed work can be accomplished with funds now available, no new appropriation is asked for at present.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$10,000
By act approved July 5, 1884	15,000
By act approved August 5, 1886	10,000
Total	35,000

Money statement.

July 1, 1886, amount available	$25,000.00
Amount appropriated by act approved August 5, 1886	10,000.00
	35,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,649.18
July 1, 1887, amount available	31,350.82

Z 10.

HARBORS OF REFUGE ON LAKE PEPIN, AT STOCKHOLM, WISCONSIN.

A crib-pier 579 feet long, extending into the lake and affording protection from storms on one side or the other in nearly all conditions of wind, was completed in September, 1885, and its description, as well as a history of this work, given in my last annual report.

This crib-pier has now passed through two winters without material injury from ice pressure.

No work was done during the past fiscal year and nothing will be done during the coming year, further than to provide for any repairs which may become necessary and for which a balance of the appropriation is reserved.

ABSTRACT OF APPROPRIATIONS.

By act passed August 2, 1882	$10,000
By act approved July 5, 1884	15,000
	25,000

Money statement.

July 1, 1886, amount available	$6,251.59
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	42.20
July 1, 1887, amount available	6,209.39

APPENDIX AA.

PRESERVATION OF THE FALLS OF SAINT ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF CHIPPEWA AND SAINT CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Preservation of the Falls of St. Anthony, Minnesota.
2. Construction of lock and dam on the Mississippi River at Meeker's Island, Minnesota.
3. Mississippi River above the Falls of St. Anthony, Minnesota.
4. Reservoirs at headwaters of the Mississippi River.
5. Chippewa River, Wisconsin.
6. Chippewa River at Yellow Banks, Wisconsin.
7. St. Croix River below Taylor's Falls, Minnesota and Wisconsin.
8. Minnesota River, Minnesota.
9. Red River of the North, Minnesota and Dakota.
10. Construction of lock and dam at Goose Rapids, Red River of the North, Minnesota and Dakota.

EXAMINATIONS.

11. Harbor at Hudson, Lake St. Croix, Wisconsin.
12. Red Lake River from Grand Forks to Red Lake, Minnesota.
13. Causes of the extraordinary overflows of the Chippewa River, Wisconsin, and what means, if any, can be adopted to prevent their recurrence.
14. Red River of the North, Minnesota, from Moorehead to Fergus Falls.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., July 27, 1887.

SIR: I have the honor to forward herewith reports upon the works and surveys in my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

A A 1.

PRESERVATION OF THE FALLS OF SAINT ANTHONY, MINNESOTA.

The first appropriation by Congress for the preservation of the Falls of Saint Anthony was one of $50,000 made by act approved July 11, 1870.

The plea for appropriations was that destruction of the falls would be followed by the conversion of the river above them into a succession of rapids, to the destruction of navigation.

The Falls of Saint Anthony are caused by the damming up of the waters of the Mississippi River by a natural barrier, consisting of a layer of limestone rock about 13 feet in thickness at the crest of the falls and less than 3 feet in thickness at its upper end, which is about 1,200 feet distant above the crest. The limestone ledge is underlaid by a mass of soft sand-rock at least 100 feet thick.

The fall is about 45 feet. The water in pouring over the crest undermined the soft sand-rock, causing the superincumbent ledge to fall down piecemeal. The crest near the middle of the river was in 1857 fully 300 feet farther down-stream than it was in 1870. The rapid rate of recession of the crest between those dates was largely due to the action of the water-power companies, chartered in 1857 by the Territorial legislature, in occupying about two-thirds of the width of the stream just at and above the crest with mill-dams and other works, and forcing the greater part of the flood volumes of the river to discharge through a width of 450 feet at the crest, thence narrowing to 360 feet, and through a fall of 45 feet to act directly upon the comparatively soft bed of the stream at the foot of the falls, thus undermining the sand-rock layer.

In the fall of 1868 an attempt was made by private parties to construct a tunnel through the sand-rock under the ledge of Hennepin Island to form a race for mills to be placed on Nicollet Island, above Hennepin, the water to be discharged through the tunnel at the foot of Hennepin Island and below the falls. On October 4, the tunnel had progressed about 2,000 feet, reaching a point near the foot of Nicollet Island. Here the water from above burst into the tunnel, and it soon became a roaring sluice-way. This disaster was followed by eruptions of water, washing out the soft sand-rock, and extensive caving of the limestone ledge followed. The mill-owners and citizens expended about $334,000 in all to avert further threatened disaster, and at an early date invoked the aid of Congress. The appropriations by Congress up to and including that by act approved March 3, 1873, were applied in attempts to exclude the water from breaks already made, as well as from new ones, by surrounding them with coffer-dams, filling up the chasms, etc., the details of which are given in pages 1161–1165, Appendix S, Part II, Annual Report of the Chief of Engineers for the year ending June 30, 1879. The total of appropriations by Congress for this work prior to 1874 was $200,000.

The project for the preservation of the falls, adopted in 1874, provided for the construction of a concrete dike beneath the limestone ledge forming the bed of the river, to prevent percolation through and consequent destruction of the soft underlying sand-rock, the construction of rolling dams to keep the upper surface of the limestone ledge flooded during the winter, and a timber apron and wings to prevent recession of the crest of the falls and consequent destruction of the dike, etc. The dike was completed in 1876, and the other works by

1878. Since 1878 work has been confined mainly to the preservation and repair of the timber structures, as described in the annual reports of the Chief of Engineers since that date.

A log-sluice was constructed at the westerly side of the main apron, under an appropriation of $10,000 for that purpose, by act of Congress approved March 3, 1879.

One crib, 80 by 80 feet, was completed during the winter of 1882 and 1883, and successfully sunk, after the manner of a caisson, in March, as described in the Annual Report for 1883.

The concrete dike is at present in good condition, but of the exterior preservative works—understanding by these the flooding-dams and timber apron and wing—the apron and wing are very much undermined by the action of ice and water and of loose saw-logs which find their way to the apron from the log-booms above the falls. The rock filling of the apron crib-work has been removed in large part by the undermining action of the water, and the deck planking is in parts torn off by running ice and logs. Should the timber apron be destroyed, the ledge would recede until the concrete dike would be endangered and possibly overthrown. The dike was constructed simply to serve as a diaphram impervious to running water, and it was not calculated to withstand, unaided by the sand-rock on its down-stream side, pressure due to a great head of water.

A radical change of plan, and such as would best serve to preserve the falls, would call for the removal of most, if not all, the mill-dams from the bed of the stream, the extension of the rolling-dams from bank to bank, and a large extension of apron-work, to consist either of timber or of concrete, the cost of the extension and repairs deemed immediately necessary being placed at $210,000, and here presented as a new estimate. The details of this estimate are given in my annual report for 1885 (see pages 1727 and 1728, Part III, Report of the Chief of Engineers for year ending June 30, 1885).

If the Government is to preserve the falls, the sum of $150,000 will be needed for the fiscal year ending June 30, 1889, to be expended toward extending the main apron to the front of Farnham and Lovejoy's Mill-pond, protecting this front so far as necessary; removal of a portion of the point of rocks from the river near the lower end of the pond in order to reduce the eddy; repairing the main apron and east apron; continuing the line of submerged cribs across the bed of the river at the toe of the apron, and for general repairs.

ABSTRACT OF APPROPRIATIONS MADE FOR FALLS OF ST. ANTHONY.

By act approved July 11, 1870	*$50,000
By act approved March 3, 1871	*50,000
By act approved June 10, 1872	*50,000
By act approved March 3, 1873	*50,000
By act approved June 23, 1874	125,000
By act approved March 3, 1875	100,000
By act approved August 14, 1876	120,000
By act approved March 3, 1879	†10,000
By act approved June 14, 1880	‡10,000
By act approved March 3, 1881	‡15,000
By act passed August 2, 1882	‡25,000
By act approved July 5, 1884	‡10,000
Total	615,000

---

* These sums were used before the adoption of the project of 1874.

† For sluice-way through public works, etc.

‡ For repairs and contingencies, etc.

The estimated cost of the project of 1874 was $419,792, and the appropriations applied to the construction of works under that project were the following:

By act approved June 23, 1874	$125,000
By act approved March 3, 1875	100,000
By act approved August 14, 1876	120,000
Total	345,000
Leaving as difference between estimated cost of complete project and amounts appropriated for same	74,792

The expenditures of appropriations from the commencement may be thus summarized approximately;

Under project prior to that of 1874	$200,000
Under project of 1874	345,000
Construction of log-sluice, under specific appropriation for same by act approved March 3, 1879	10,000
In repairs to and in maintenance of the works, including large cribs, 1878-1886	[*]60,000
Total of appropriations by Congress	615,000

No work of improvement or of repairs could be undertaken during the past fiscal year, for want of funds. A watchman was formerly employed to make daily inspection of the exterior works and to guard against injury to them by acts of private parties, but the funds having been exhausted by August 31 last, the watchman was discharged and the engineer property at the falls was sold under authority at public auction, there having been no means of paying for further care of the property. The proceeds of the sale, $713.18, were deposited to the credit of the Treasurer of the United States.

Since September 1st last, this office has been without the means of caring for or properly inspecting the works.

No steam-boats have navigated the river between the Falls of St. Anthony and Aitkin, about 208 miles by river above the falls, for seven or eight years, excepting, so far as known, one steamer, which made an excursion trip in 1884 from Brainerd to Fort Ripley, a point about 133 miles above the falls; hence there is no navigation dependent upon the preservation of the falls. The commercial statistics of Minneapolis refer entirely to the products of the water-power and shipments of lumber, flour, groceries, etc., by rail.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn. Collections from all sources for year ending December 31, 1886, $4,591.74. Value of domestic exports for 1886, $2,419,847. "In transit" trade, 1886: Value of merchandise, $94,450; duties on same, $52,576.97.

Money statement.

July 1, 1886, amount available		$101.54
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$14.71	
July 1, 1887, outstanding liabilities	86.83	
		101.54

Amount (estimated) required for project	210,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

---

[*] Of this amount $14.71 was expended during the fiscal year ending June 30, 1887.

A A 2.

CONSTRUCTION OF LOCK AND DAM ON MISSISSIPPI RIVER AT MEEKER'S ISLAND, MINNESOTA.

The project for this work is given in the report of the Chief of Engineers for the fiscal year ending June 30, 1874, and the cost estimated at $922,121.46, the object being to connect with the improvement of the Mississippi River below Saint Paul, so as to secure steam-boat navigation up to the Falls of St. Anthony.

No improvement of the river between Saint Paul and site of the proposed lock and dam has been authorized by Congress.

Congress by act approved July 23, 1868, made a grant of 200,000 acres of public lands to the State of Minnesota to aid in constructing a lock and dam at this point, in accordance with plan and estimate previously submitted.

By act approved March 3, 1873, Congress appropriated—

> For construction of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, $25,000: *Provided,* That all rights and claims in and to the land grant made to the State of Minnesota for the above work, by act approved July 23, 1868, shall be fully relinquished to the United States before any of this appropriation is expended.

None of this appropriation has been used, the required relinquishment not having been made.

This appropriation, but little more than 2½ per cent. of the estimate, has been lying unused for fourteen years.

A survey of the Mississippi River between Saint Paul and St. Anthony's Falls, provided for in the river and harbor act approved August 5, 1886, is in progress, and upon its completion a full estimate of the cost of an improvement will be rendered. Consequently, no appropriation for the fiscal year ending June 30, 1889, is asked in this report.

It is claimed by those favoring an improvement of the Mississippi River to the Falls that, were the channel made navigable to that point, a large portion of the 5,000,000 to 6,000,000 barrels of flour annually manufactured at Minneapolis would find its way to market by river and at reduced cost to consumers. At present, a light-draught steamer only makes occasional trips from the Saint Paul steam-boat landings to points in the vicinity of Meeker's Island.

This proposed work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn. Collections from all sources during the year ending December 31, 1886, $4,591.74. Value of merchandise, "in transit" trade, $94,540. Duties on same, $52,576.97. Value of domestic exports, $2,419,847.

Beyond the running of loose saw-logs over the portion of the river to be rendered navigable by the proposed lock and dam there are no commercial statistics of importance to report.

Money statement.

July 1, 1886, amount available, subject to conditions in act	$25,000.00
July 1, 1887, amount available, subject to conditions in act	25,000.00
Amount (estimated) required for completion of existing project	897,121.46
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

A A 3.

IMPROVEMENT OF THE MISSISSIPPI RIVER ABOVE FALLS OF SAINT ANTHONY, MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon the project for the improvement of 252 miles of the river, from Conradi's Shoals to Grand Rapids, the latter the present head of steam-boat navigation; the estimated cost, $54,127.50, as given in the report of February 8, 1875, upon part of the Mississippi transportation routes to the sea-board; plan of improvement to afford 3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing-dams where necessary.

This same report estimated the cost of improvement of the river between the Falls of Saint Anthony and Saint Cloud at $144,667.50, the improvement of this section to afford 5 feet depth in the channel at low water between the Falls and Saint Cloud, by removal of sand, gravel, and bowlder bars, and the construction of wing-dams. The sum of $20,000, appropriated by act of Congress approved August 14, 1876, was expended between those places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of $25,000 for improvement of the river above the Falls of Saint Anthony, which was also expended in improving the channel between the Falls and Saint Cloud.

Steam-boat navigation having discontinued between the Falls and Saint Cloud, a distance of 76 miles, the third appropriation made by Congress, that of $15,000, by act approved June 14, 1880, was applied to the stretch, 165 miles in length, of river between Aitkin and Grand Rapids, which stretch is included within the distance from the rapids to Conradi's Shoals, as have been all subsequent appropriations for improving the river above the Falls of Saint Anthony.

No work towards this improvement was performed during the past fiscal year, there being no funds for the same, the last appropriation for the work having been made by act passed August 2, 1882.

Amount expended on the present project to June 30, 1887, including outstanding liabilities, $35,000.

Amount expended on the same during the fiscal year ending June 30, 1887, including outstanding liabilities, $1.90.

Before work of improvement commenced under the present plan the stream between Aitkin and Grand Rapids was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult, and sometimes almost impossible, for steamers drawing less than 3 feet of water. There is now a general depth in the improved channels of 3 feet at low water, though many masses of gravel and bowlders yet require to be removed in order to afford sufficient width. Snags form more or less every season, and caving bends furnish leaning trees or sweepers. The movement of ice in the spring also causes deposit, more or less, of bowlders in the channels.

The three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon henceforth to provide sufficient depth for the steam-boats on the river at and above Aitkin, but the obstructions, as bowlders, etc., should be removed, as they contract the channel and interfere with the movements of steamers at any stage of water.

The rapid caving of the banks in many places is due to the powerful wheel of the steamer *Andy Gibson*, which carries passengers, freight, nd supplies to the lumbermen's camps and settlements, the steamer eing too long, over all, for the narrow widths and sharp bends which ccur on this part of the stream.

The sum of $15,000 can be profitably expended during the fiscal year nding June 30, 1889, in continuing the removal of obstructions from he river between Aitkin and Grand Rapids, the piece of river to which team-boat navigation above the Falls of Saint Anthony is at present onfined.

It is not possible to obtain, at this time, complete statistics of the ommerce of this part of the river for this season to include June 30. here are at present three steamers with barges engaged in freight nd passenger transportation between Aitkin and Grand Rapids. The omparative tables of commercial statistics herewith show that in 1880, he year in which the work of improvement between Aitkin and Grand apids commenced, there was but one steamer (with its barges) plying etween those points and that. Though the amount of freight transorted that year by steamer was unusually large, the freight rates vere from 75 cents to $1 per 100 pounds; while in 1883, 1884, 1885, and 886, the rates reduced to 20 to 40 cents per 100 pounds. The lastamed figures obtained in 1886, at which time there were three steamoats engaged in freighting and carrying passengers between Aitkin nd Grand Rapids. The country bordering the river north of Aitkin s becoming more and more settled, and there is no doubt that the improvement of the river already effected by the United States Government has largely contributed to the increase in settlement.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn. Collections from all sources during the year ending December 31, 1886, $4,591.74; value of merchandise "in transit" trade, $94,540; duties on same, $52,576.97. Value of domestic exports, $2,419,847.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING MISSISSIPPI RIVER ABOVE THE FALLS OF SAINT ANTHONY, MINNESOTA.

By act approved June 23, 1874	*$25,000
By act approved August 14, 1876	*20,000
By act approved June 14, 1880	15,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	*10,000
Total	80,000

Original estimates for the work between Grand Rapids and Conradi's Shoals		54,127.50
Appropriations by acts—		
June 14, 1880	$15,000	
March 3, 1881	10,000	
August 2, 1882	10,000	
		35,000.00
Remaining to be appropriated		19,127.50

Money statement.

July 1, 1886, amount available		$5.57
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1.90	
July 1, 1887, outstanding liabilities	3.67	
		5.57

Amount (estimated) required for completion of existing project, viz: improvement between Grand Rapids and Conradi's Shoals	19,127.50
Amount that can be profitably expended in fiscal year ending June 30, 1889	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

---

* Made and expended before the adoption of the present project.

COMMERCIAL STATISTICS.

Comparative statement of the steam-boat business on the Mississippi River between Aitkin and Grand Rapids, of the logs run, and of the lumber, shingles, and lath manufactured on the river above the Falls of St. Anthony, for a period of seven years, 1880 to 1886, inclusive.

Year.	Steam-boats.	Freight carried.	Passengers carried.	Logs run.	Manufactured.		
					Lumber.	Shingles.	Lath.
	No.	*Pounds.*	*No.*	*Feet B. M.*	*Feet B. M.*	*No.*	*No.*
*1880	1	7,874,256	1,000	226,000,000	241,157,989	88,446,125	49,427,100
1881	1	2,200,000	1,540	238,000,000	339,162,197	128,532,050	70,380,750
1882	2	3,026,000	1,764	285,000,000	423,009,250	168,844,000	77,898,000
1883	2	2,800,000	1,100	420,000,000	398,178,995	132,212,450	81,193,825
1884	2	16,000,000	1,346	367,000,000	389,178,995	123,487,300	101,087,360
1885	2	5,000,000	2,400	317,998,000	340,020,000	122,534,000	84,012,000
†1886	3	8,000,000	3,500	282,600,000	282,248,700	103,928,000	58,958,000

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time (1886).

Shippers of freight do not insure their cargoes. The effect of the work thus far executed has been to lower the rates on freight, between Aitkin and Grand Rapids, about 50 per cent.

There are no *competing routes* of transportation, as the steam-boats do about all the carrying trade during the seasons of navigation. There were, during the season of 1886, three steamers which competed with each other.

[NOTE.—Following the appropriation of $15,000, made by river and harbor act approved June 14, 1880, the project for the work between Grand Rapids and Conradi's Shoals was adopted.]

Following are rates of freight from Aitkin to Grand Rapids, from 1880, when work of improvement began, to 1886, inclusive:

Years.	Rate per 100 pounds.	Years.	Rate per 100 pounds.
1880	$0.75 to $1.00	1884	$0.40 to $0.50
1881	.75 1.00	1885	.25 .40
1882	.75 1.00	1886	.20 .40
1883	.50 .75		

The foregoing table shows the benefits to the community in the matter of the saving of expenses in getting their supplies of all kinds to and from market.

A A 4.

RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the reaches of the several streams below the dams, and also that of the Mississippi below Saint Paul. Alleviation of floods in localities near the proposed reservoirs expected to obtain to some extent, but control of extended floods or freshets covering long reaches not expected.

In order that navigation may be benefited upon the Mississippi above he mouth of the St. Croix, upon the St. Croix, the Chippewa, and the avigable reaches of the Wisconsin, the system of dams proposed for ach must be carried out, and no benefit of consequence to the Missisippi below Lake Pepin can be predicted unless the entire system be uilt.

The capacities of and supply to the proposed reservoirs are discussed n the several reports upon reservoir surveys of January 15, 1879, Deember 12, 1879, January 15, 1880, and January 16, 1881.

Appendix X, Part II, pages 1457–1459, Report of the Chief of Engineers, 1883, contains a résumé of hydrological observations and conclusions based thereon.

The project for this work may be said to have been adopted in 1880, following an appropriation by Congress for the work by act approved June 14, 1880.

The system as originally reported upon comprises 41 reservoir dams in Minnesota and Wisconsin, at an estimated first cost (omitting that of land, etc., damages) of $1,809,083.

The dam on Pine River at the outlet of Cross Lake, Minnesota, was fully completed in October, 1886, the work of the fiscal year consisting in sodding and riprapping slopes of embankment and in filling the body of the dam with additional stone; in finishing the dike at the south end of Whitefish Lake; and in filling up a large depression in the bed of Pine River just below the apron of the dam.

The dam has a lift of 17 feet, and was constructed as follows:

Total length of dam, 1,500 feet. Of this length 235 feet are of crib-work filled with rock. The crib-work is 26 feet wide, rests on a pile foundation, and is provided with 14 sluices, viz, 13 sluices 4 by 4 feet in the clear, and one log sluice 10 feet in width. The piles are driven to a firm bearing and capped with 10 by 10 inch and 12 by 12 inch timbers. On these caps is laid the main apron, which is also the floor of the sluices. This flooring is of two layers of plank, one 8 inch and one 4-inch layer. In the foundation are six rows of sheet-piling, five of 6-inch and one of 8-inch thickness, the 8-inch row, the principal one, being driven to a depth of 14 feet below the caps. Between the 8-inch row and one of the 6-inch rows of sheet-piling is a trench filled with puddled clay, capped with a layer of concrete. Between the timber caps and under the flooring the space is filled with injected cement mortar.

The length of the embankment and dikes is 1,265 feet, the embankment having a diaphragm of plank, on either side of which is a puddled core. The embankment slopes are 1 on 3, and revetted with sods and broken bowlders. The wings of the dam are of strong crib-work filled with stone. The hoisting machinery for raising the sluice-gates is a worm gearing of the same style as that used for the Winnibigoshish and Pokegama dams. The dike at the south end of Whitefish Lake (the lake forming part of the Pine River Reservoir), crossing a depression between that lake and the valley of Pelican Brook, is 167 feet in length and 13 in height, and is 10 feet wide at top, with slopes of 1 upon 3; the top of dike is 5 feet above the flowage line of the reservoir; a diaphragm of 6-inch plank extends lengthwise of the dike; the front slope and top of the dike being riprapped. The capacity of this reservoir is 7,000,000,000 cubic feet. The materials for construction were, as in the case of the dams already built, mostly obtained in the country adjoining the dam.

Following are the sumarized items of material for the Pine River Reservoir during the fiscal year:

Rock for filling and slopes	cubic yards..	1,536
Brush fascines	do....	391
Sawed timber	feet B. M..	4,173
Sand filling	cubic yards..	365

The sand filling was used in the depression in the bed of the river below the dam. Upon this filling were placed 391 cubic yards of brush fascines, the latter covered with 572 cubic yards of large and small bowlders.

TOTAL SUMMARIZED ITEMS FROM COMMENCEMENT OF WORK UPON THE PINE RIVER RESERVOIR, 1884, TO JUNE 30, 1887.

Embankment	cubic yards..	13,967
Excavation	do....	6,606
Puddled clay and filling in trench	do....	1,271
Concrete in trench	do....	80
Rock for filling and slopes	do....	6,272
Brush	do....	557
Round piles driven in foundation and coffer-dams	number..	925
Timber in dam, and for coffer-dam	feet, B. M..	1,496,016
Iron, including drift-bolts, spikes, nuts and washers, and nails	pounds..	154,300
Hoisting machines	mounted..	15
Total of timber sawed	feet, B. M..	1,728,046

Thirteen of the machines are for hoisting sluice-gates, one machine for hoisting log-sluice wickets, and one machine for hoisting stop-plank.

The timber was sawed by day labor, and used in dam and coffer-dam, for building quarters, sheds, flats, stop-plank, gates, repairing boats, gang-plank, track, etc. The slabs and edgings furnished fuel for the saw-mill and for men's quarters. The coffer-dam was of two parts; one built in the winter of 1884-'85; the other during the fall of 1885; the object being to provide for the free discharge of the river while the work was in progress. All the work was done by day labor.

The work upon the dams during the past fiscal year has been in local charge of Assistant Engineers Archibald Johnson and John Cullen, who are deserving of credit for the faithfulness and zeal with which they discharged their duties. Mr. Johnson's report upon operations at the Pine River Dam is herewith.

Mr. F. T. Hampton, principal assistant, also rendered valuable services in connection with these works as well as upon others.

CONDITION OF THE WORK.

In addition to the Pine River Reservoir are the following:

Reservoir.	Completed in—	Capacity.	Time required to fill.
		Cubic feet.	
Lake Winibigoshish	August, 1884	40,000,000,000	26 months.
Leech Lake	September, 1884	22,000,000,000	2 years.
Pokegama Falls	October, 1884	8,000,000,000	1 to 2 months.

A force of watchmen was necessarily employed during the year at the completed dams at Winibigoshish, Leech Lake, and Pokegama, and also at Pine River, in order to guard the works and the property, which consists of steamers, saw-mills, flats, pumps, and tools. The watchmen also acted as dam-tenders.

Expended to June 30, 1887, upon all the works, including outstanding liabilities, $583,573.33, which amount includes cost of plant and works, examinations, land damages and attendant examinations, awards to Indians for damages, superintendence, contingencies, etc.

During the year the discharge of water from the completed reservoirs was continuous, varying according to the needs of the river and so far as the partially completed system would furnish water. The details of the discharge of water in the interest of navigation during the season of 1886 are given in my report and project submitted to the Chief of Engineers, November 5, 1886. The years 1885 and 1886 were dry ones for Minnesota and parts of Wisconsin and Dakota. The average annual precipitation at Saint Paul is about 30 inches. In 1885 it was 25.33 inches, and in 1886 but 21.89.

From June 1 to October 31, 1886, inclusive, one hundred and fifty-three days, the reservoirs added to the volume of the Mississippi from 1,000 to 1,900 cubic feet of water per second. Had this flow of one hundred and fifty-three days been compacted into a period of ninety days, from August 1 to October 31, the volume, per second, would have been greater and the depth effect correspondingly so. From such observations as means admitted of in 1885 and 1886 and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at Saint Paul, the effect of every 100 cubic feet per second, of water added to the river and steadily maintained, was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each 100 cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886, that the effect of the liberated water from the four reservoirs was the addition of 1 foot and upwards to the depth at Saint Paul, during the dry periods of those years, the additional depth being due to elevation of water-surface as well as to additional scour. When the river reaches very low stages, a slight increase, even, in channel depth, if only enough to lift a boat free from a bar, may decide the question of navigation for the rest of the season. The system of reservoirs was proposed as a powerful auxiliary to other works for river improvement.

The operations of the reservoirs in the interest of navigation are much impeded by the action of lumbermen, who build dams at the outlets of lakes or on streams tributary to the Mississippi River in order to gather water for driving their logs. Some of these dams are permanent structures, others are temporary. In the basin of a single tributary to the Mississippi above Saint Paul, 25 such dams exist to-day; some of them have been lately built. There are probably more than 100 such dams in the basin of the Mississippi River above Minneapolis. One dam alone on Prairie River impounds enough water to represent a discharge of 800 to 1,000 cubic feet of water per second for many days. The water is impounded and released at the will of the owners of the dams, without system, other than to get immediate results, for their own drives of logs. Many, if not all, of these private dams are closed from July until the following April, in order to collect water, thus depriving the river, during the seasons of drought, of water needed for *navigation and power*. It is believed that 15 to 20 per cent. of the water due the river above Minneapolis is controlled in this way. The water is liberated in the spring at a time when it is not needed for navigation and power, and, on the other hand, is withheld from the river when most urgently needed. When it is considered that the headwaters of the St. Croix, Chippewa, Wisconsin, and other tributaries are encumbered by similar dams, operated in a like manner, the very low stages of water that frequently occur in the Mississippi River from its sources to and below the mouth of the Wisconsin River may be in some degree accounted for. The practice of withholding water from the river in the manner stated has become one of such magnitude that it would appear as though legislation in the premises were necessary. Log-driving can be managed so as to reduce the present waste of water, but it will never be done until laws are enacted to control it.

In my annual report for the year ending June 30, 1886, were the following remarks:

> The construction of reservoir dams commenced in Minnesota for the reason that the first appropriation of money for the system was for the construction of a dam at Lake Winnibigoshish, and again because releases against damage for overflow of private lands were voluntarily offered on a large scale; and for the same reasons it has continued in Minnesota. It would seem best to complete the reservoirs at the headwaters of the Mississippi, above Minneapolis, before extending the work in other directions, mainly because the best opportunity will thus be afforded of testing in all its bearings a project which has thus far proven successful from an engineering point of view, especially so far as the ability to collect water is concerned, though there may be questions as to expediency that do not come within the province of the engineer, and leading to results that he has not the means of predicting.

A difficulty was encountered early last season at the Pine River reservoir dam which had been sufficiently completed to admit of collecting a considerable quantity of surplus water. The log-cut of the Pine River Valley was unusually large during the preceding winter and the log-drives reached the dam in May and June following, with unnecessarily long intervals of time between their arrivals, instead of reaching it promptly and in compact shape. These logs, of course, had to be admitted through the sluice, and, owing to the dilatory manner in which they were handled by their drivers, were fully three times as long in passing the dam as there was any necessity for, and the result was a great expenditure of water.

As a result of the experience of last season the loggers were, this year, verbally notified that logs in reasonably large booms upon reaching the dam would be sluiced, and that as soon as the boom had passed the dam the discharge of water would be reduced. This was carried out in spite of much difficulty with the loggers, who, through the employment of insufficient crews to man their drives, were longer in sluicing than there was any excuse for.

The watchmen at the dams have always been directed not to obstruct the passage of booms of saw-logs; but they have also been directed not to allow the dams to be used for the furtherance of any private interest. The act of Congress passed August 2, 1882, in appropriating for the reservoirs contained the following:

> *Provided further*, That the money hereby appropriated shall be used solely for the improvement of the navigation of the Mississippi River and its tributaries, and no part thereof shall be expended with the view to the improvement of private property.

The river and harbor act of Congress approved July 5, 1884, repeated that provision.

All difficulty in regard to sluicing of logs and waste of water consequent thereupon could be obviated by an act of Congress providing that no logs shall be sluiced through a Government reservoir dam before August 1 of any year, and then for a period not longer than forty days.

The annual cost of guarding, maintaining, and operating the reservoir dams at Lake Winnibigoshish, Leech Lake, Pokegama Falls, and Pine River is estimated at $12,000.

The original project for reservoirs at the headwaters of the Mississippi above Minneapolis provided for dams at Mud Lake, Vermillion River, and Gull Lake, in addition to those that are already built. Late experience has demonstrated that the proposed Mud Lake and Vermillion River dams can be dispensed with, as the three reservoirs, viz., Winnibigoshish, Leech Lake, and Pokegama, will suffice, if the lift of the latter be increased 2 feet, to collect water above Grand Rapids. Recent investigation also leads to the conclusion that the cost of damages from creating the proposed Gull Lake Reservoir, at present, will be excessive. Gull Lake and River and their tributaries are now encumbered with numerous logging dams owned and operated by private parties and held at high valuation.

When the destruction of forests ceases in the valley of the Mississippi above Minneapolis, and forest-growth and timber-cutting are regulated by law, the reservoir system of the Upper Mississippi can be extended to include the Gull River and Prairie River basins and others. The system will then attain its maximum value to the public. These remarks as to regulation of timber-cutting and forest-growth apply also to the Saint Croix, Chippewa, and Wisconsin.

It is proposed to apply, with the approval of the Department, the sum of $37,500, appropriated by act of August 5, 1886, to increasing the lift of the Pokegama Reservoir; to maintaining, operating, and guarding the four completed reservoirs; and to a preliminary examination of Sandy Lake and River.

An effective reservoir, and one as valuable as that originally proposed for Gull Lake, can undoubtedly be created at Sandy Lake and River, tributary to the Mississippi River at a point 60 miles above Aitkin. As to this, Assistant Engineer Davenport reports as follows:

> Sandy Lake has an area, at low water, of about 9 square miles; there are large areas of marsh and swamp in the vicinity of the lake and its tributary streams. With a head of 5 feet the flowage area is estimated at 12 miles, and the capacity, with that head, would be about 1,500,000,000 cubic feet, sufficient to furnish 650 cubic feet per second for thirty days.
>
> The area of the water-shed is estimated at 370 square miles, which would give nearly 7,000,000,000 cubic feet for the annual supply (rainfall estimated at 27 inches; one-fourth rainfall estimated as available).
>
> The supply from the water-shed would supply a much larger reservoir than would be formed by a 5-foot dam; but as the banks are in places low, it is believed that a much greater head might require extensive dikes. This only can be determined by a survey.
>
> The annual cut of pine from this section is about 5,000,000 feet, B. M., and it is estimated that the total quantity now standing will not exceed 100,000,000 feet, B. M.
>
> The outlet from the lake into the Mississippi is about 1 mile long. At the narrowest point the width at the water-line is less than 100 feet, and at the top of the bank will not exceed 300 feet It is estimated that a dam something similar to that at Leech Lake could be built for $12,000.
>
> It is reported that some of the lands adjoining the lake are owned by private parties, but that large areas are still in possession of the State and of the United States Government.
>
> One of the principal objects for the construction of a dam at this place would be to prevent the temporary loss of water required to raise the lake when a large discharge is being made from the upper reservoirs.

Sandy Lake and River are worthy of a thorough survey, the cost of which is estimated at $4,000.

The report of December 18, 1885, above referred to, recommends the condemnation for reservoir purposes of certain low lands or meadows below Pokegama Falls which are liable to be damaged by the maximum flow of water from the reservoirs. These lands have always been subject to overflow from natural floods, but they produce hay when seasons of low water occur.

The cost of condemnation of these lands is estimated as follows:

400 acres, at average cost of $8 per acre	$3,200
Condemnation expenses (estimated)	800
Total	4,000

To increase the lift of Pokegama Reservoir 2 feet will require the construction of two dikes at the eastern end of the resorvoir, and as follows:

DIKE IN NORTHWEST QUARTER OF NORTHEAST QUARTER OF SECTION 24, TOWNSHIP 55, RANGE 25.

36,000 feet, B. M., plank for diaphragm, at $20 per M, in place	$720.00
194 square rods grubbing, at $2	388.00
Clearing 3 acres of timber, at $40	120.00
Removing 2,214 cubic yards of marshy ground, at 30 cents	664.20
5,725 cubic yards embankment, at 40 cents	2,290.00
179 square rods sodding for slopes, at $3	537.00
Total	4,719.20

DIKE EAST OF HALE LAKE.

36,210 feet, B. M., plank, at $20 per M, in place	724.20
82 square rods of grubbing, at $2	164.00
Clearing 2 acres of timber, at $40	80.00
Removing 1,111 cubic yards of marshy ground, at 30 cents	333.30
3,659 cubic yards embankment, at 40 cents	1,463.60
95 square rods sodding for slopes, at $3	285.00
Total	3,050.10

For both dikes	7,769.30
Quarters for men	500.00
Contingencies, 15 per cent., including alteration of hoisting machinery for log-sluice	1,240.39
Total	9,509.69

The sum of $12,000 can be profitably expended during the fiscal year ending June 30, 1889, in maintaining and operating the completed dams.

For commerce benefited and to be benefited by the reservoir system reference must be made to the commercial statistics of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers.

Amounts appropriated are:

Act approved June 14, 1880	$75,000
Act approved March 3, 1881	150,000
Act passed August 2, 1882	300,000
Act approved July 5, 1884	60,000
Act approved August 5, 1886	37,500
Total	622,500

Allotment per letter from office of Chief of Engineers, November 9, 1881	1,572.15
Allotment per letter from office of Chief of Engineers, January 20, 1882	176.00
Allotment per letter from office of Chief of Engineers, April 21, 1887	8.60
Awards to Indians for damages in connection with the building of Leech Lake and Lake Winnibigoshish dams, letter from office of Chief of Engineers, August 7, 1885	15,996.90

Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam-sites, letter from office of Chief of Engineers, May 27, 1881	$7,500.00
Expended by officer in charge in connection with the building of four reservoir dams to June 30, 1887, including outstanding liabilities	558,319.68
Total allotted and expended to June 30, 1887, including outstanding liabilities	583,573.33
Estimated cost of the system (omitting that of land, etc., damages)	1,809,083.50
Amounts appropriated to include appropriation by act approved August 5, 1886	622,500.00
Remaining to be appropriated	1,186,583.50

Money statement.

July 1, 1886, amount available		$16,518.93
Amount appropriated by act approved August 5, 1886		37,500.00
		54,018.93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$14,389.92	
July 1, 1887, outstanding liablities	702.34	
		15,092.26
July 1, 1887, amount available		38,926.67

Amount (estimated) required for completion of existing project	1,186,583.50
Amount that can be profitably expended in fiscal year ending June 30, 1889	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. ARCHIBALD JOHNSON, ASSISTANT ENGINEER.

SAINT PAUL, MINN., *November* 30, 1886.

SIR: I have the honor to submit the following report of the construction and cost of Pine River Dam:

This dam is built across Pine River about one-fourth of a mile from where it leaves Cross Lake, and is located in the west half of the northwest quarter of section 21, of township 137 north, of range numbered 27 west of fifth principal meridian. Its distance from the Mississippi by river is about 18 miles; and its distance from Brainerd, the nearest town, is about 30 miles by a road.

The country north of Brainerd, and in the vicinity of the dam, is still a wilderness, and about the only business carried on is that of lumbering.

The river at the dam-site is about 145 feet wide, and the formation consists of sand and clayey sand. The bed of the river at this point is covered with a stratum of clayey sand which is very hard and impervious to water, and varies in thickness from nothing to 10 or 12 feet.

Preliminary operations for the construction of this dam were made in February, 1884, and it was completed in November, 1886. Supplies of all kinds, excepting timber, hay, and some vegetables, were purchased either in Brainerd or Saint Paul. All the machinery used was received from Leech Lake, Winibigoshish or Pokegama dams, which reduced the cost of the work very materially.

SAW-MILL AND SAWING.

The saw-mill machinery used at Pine River Dam was that used at Leech Lake and Winibigoshish dams, and was transported to Pine River in March, 1884. The construction of the saw-mill was commenced in April, and completed in June, 1884.

The capacity of the saw-mill for the timber needed in the dam was from 20,000 to 25,000 feet B. M. per day of ten hours. The sawing was commenced in the latter part of May, 1884, and completed in October, 1885. As the lumber was being sawed the slabs were sawed for fuel for quarters and engines.

The total amount of timber sawed, according to the mill-scale, was 1,728,046 feet B. M.

forming the diaphragm proper in the foundation, a trench was dug between the second and third rows of 6-inch sheeting 8½ feet wide and 7½ feet deep below the top of the caps. The water was kept out of the trench with a 6-inch Heald and Sisco pump. In the north half of the dam the 8-inch sheet-piles were shod with straps of iron 2 feet long, 5 inches wide and three-sixteenths of an inch thick. This saved the pile considerably and assisted the penetration. In the south half of the dam a cast-iron shoe was used for most of the 8-inch sheeting. The sole of the socket was 3 inches thick and 3 inches wide on the bottom, with a bevel of 1¾ inches in 11½ inches. It was 6 inches deep and the sides were one-half inch thick. This proved to be a good shoe, and the bevel about right.

In driving this sheeting a 2,000-pound hammer was used, operated by a hoisting engine. While driving through the sand a jet of water from a half-inch pipe connected with a hose from a force-pump worked by hand power, was used in loosening the sand around the pile. This not only expedited the work, but enabled us to keep the pile in actual contact with the preceding one, and thus have perfect joints. All these sheet-piles were driven into a firm stratum of clay. They were driven, as well as the 4-inch and 6-inch sheet-piles, until the penetration was not more than one-quarter of an inch from the blow of a 2,000-pound hammer falling from 8 to 12 feet. A cast-iron cap or follower with a rectangular socket at the lower end to receive the head of the pile, and a wooden block placed in a circular socket at the upper end to receive the blows of the hammer, was used. This saved the head of the pile from brooming.

FILLING TRENCH AND BETWEEN AND UNDER CAPS.

The trench to a depth of 6 feet under the crib-work was filled with a mixture of clay and sand. There seemed to be enough clay in it to fill the voids in the sand. The last 25 feet at each end and beyond the crib-work was entirely filled with this material. In its natural state it is a sort of hardpan.

Under the crib-work in the trench, the last 18 inches were filled with concrete. The proportions used in the north half were 1 part cement, 2 parts sand, and 4 parts broken stone. In the south half, 1½ parts cement, 2 parts sand, and 4 parts broken stone were used.

Between and under the caps, the spaces were filled with a sandy clay, sandy loam and sand, all well tamped and rammed under the flooring as it was laid. Sandy clay was invariably placed next to sheeting.

FLOORING.

The flooring of the dam consists of two courses, the first being 8 inches and the second 4 inches thick. The 8-inch course is fastened to the caps with ¾-inch by 16-inch drift-bolts of round iron, one bolt at each end and one at each intersection with a cap. The 4-inch course is fastened to the 8-inch with ½-inch by 9-inch boat-spikes, two at each end and one every three or four feet, alternating from side to side. After the flooring was laid, cement was injected into it through a 16-foot gas-pipe and all the spaces filled.

CRIB-WORK OF THE DAM.

Commencing at the north side, the crib-work may thus be described:

First is a crib 16 by 28 feet, extending into the embankment. Connected with this is the north log-sluice pier, which is 85 feet long. At the upper end of the log-sluice pier and framed into it is the north upper wing-wall, flaring out at an angle of 23° 20′. and stepping down with a slope of about 3 horizontal to 1 vertical until a level of 15 feet above the floor is reached. The upper end of this wing-wall is 54 feet long, and is parallel to the axis of the dam. Next is a clear opening of 10 feet wide above the floor for the log sluice. The walls of the sluice are lined with 3-inch and the floor with 4-inch oak plank. It has 5 vertical slots for stop-plank, the upper one being at the face of the crib-work for the sluices, and the others below this and 15 feet apart. In each wall of the log-sluice piers is an inclined slot with a slope of 7 horizontal to 1 vertical. The upper sides of these slots are 3 feet above the floor at the lower end.

In these slots can be placed 8 by 12 inch horizontal timbers with an angle-iron at the upper side to form a slide for logs when too much water would pass through on the floor of the log sluice. Next is the south log-sluice pier, 12 feet wide and 85 feet long; and framed into this is the crib-work for the sluices and waste sluices. This portion is 129 feet long and 26 feet wide. It has 13 sluices 4 by 4 feet, lined with 4-inch plank, and controlled by gates operated by worm-gear machines and racks. The floor of these sluices is the floor of the dam, and is 18 inches below low water. In the top of the crib-work there are 14 waste sluices, 4 feet wide and 5 feet deep, and walls lined with 2-inch plank. The floor of these waste sluices is 3½ feet below the flowage line, and they are controlled by 4-inch stop plank at the lower end. The cross-ties in the crib-work for the sluices are 9 feet from center to center, and are allowed to project 6½ feet above the upper walls and 4 feet below the lower walls. They are filled in between with blocks and then faced with two courses of 3-inch plank which slots are formed at the upper and lower ends for stop plank, which can be ed, if necessary, instead of the gates. The next portion of the crib-work is the south ore pier, 73½ feet long and 12 feet wide. Connected with the upper end is a wing- all 40 feet long, similar to the one on the north side. The top of the two log-sluice ers and the south shore pier is 84 feet long at a level of 21 feet above the floor, and ep down in front to conform to the slope of the embankment. The lower end of each ore pier has a wing-wall 16 feet long and 9 feet high. The crib-work of the sluices 20 feet above the floor, and the 16 by 28 foot cribs 21 feet, or 2½ feet above the flow- ge line.

The most of the timber below low water is Norway pine. The walls of the crib- ork, cross-ties, and longitudinal ties for a height of 15 feet above the floor, and the ner 11 cribs between the waste sluices, are of 12 by 12-inch white pine. The re- mainder is of 10 by 10-inch Norway pine. All the crib-work is constructed with 1 y 20-inch bolts and ¾-inch by 20-inch bolts of round iron. In the walls the bolts re about 4 feet apart, and in the ties they are used at the intersections.

EMBANKMENT OF DAM.

The embankment of the dam is built 3 feet above the flowage line, and all of it has lopes of 3 horizontal to 1 vertical. In the north embankment the first 210 feet has a vidth at the top of 14 feet before any sodding or riprapping was placed on it. The natural surface along this portion is from 1 to 8 feet below the flowage line. The remainder of the north embankment, 885 feet, has a width of top of only 10 feet or 28 eet at the water-line. Along this portion, however, the natural surface of the ground is only 2½ feet below the flowage line at the lowest places. The top of the south embankment, which is 190 feet long, is 14 feet wide. Here the natural surface is from 0 to 10 feet below the flowage line.

There is a timber diaphragm in the center of the entire embankment, and it is cut off 1 foot above the flowage line. In the north embankment, the first 25 feet is spliced to the 8-inch sheeting in the trench. It is 6-inch timber battened with 1-inch boards. The next 110 feet is also 6-inch plank, and beyond that for 90 feet it is 4-inch plank, all down at least 10 feet below the natural surface of the ground. This is also battened with inch boards. Along the 225 feet is a puddled wall of clayey sand. The top of it is 1 foot above the diaphragm, where it is 6 feet wide. It extends down to the bottom of the diaphragm, and its slopes are 3 inches horizontal to 12 inches vertical. The rest of the north embankment has a diaphragm of 2-inch plank, extending down 4 feet below the natural surface of the ground. In the south embankment there is 175 linear feet of 6-inch diaphragm. The first 25 feet is spliced to the 8-inch sheeting in the trench, and extending into the hill 25 feet beyond where the flowage line cuts it. It is battened the same as the other. At this end is a bed of clay and sand mixed, in which a trench 2 feet deep was dug, and in which was set the timbers of the diaphragm. Along this diaphragm is a puddled core the same as on the north side. In constructing the diaphragm of 6-inch and 4-inch plank, the first piece was drift-bolted to the crib-work at each end, and then each succeeding piece was drift-bolted to the previous one with 2 ¾-inch bolts.

The material in the slopes of the embankment is sand and sandy loam, the last 12 inches on top and in slopes being from the first 6 inches of the ground in the vicinity.

The whole of the south embankment, and the first 225 feet of the north embankment, has been covered with 6 inches of sod. The upper slope and the first 3 feet of the top has been covered with 6 inches of broken stone of the size of cubes of 1½ or 2 inches. The upper slopes and top of the embankment, so far as sodded, were then covered with 12 inches of riprap of bowlders.

DIKE.

The dike is located on the line between sections 21 and 22, township 127 north, range 28 west of fifth principal meridian. It is 167 feet long, and has slopes of 3 horizontal to 1 vertical. The top is 10 feet wide and 5 feet above the flowage line. The lowest part of the ground on which it is built is 8 feet below the flowage line. Three feet below the lowest place is a bed of clay 8 feet thick. A trench 4 feet wide at the bottom was dug until the clay was reached between the points where the flowage line cuts the slope of the ravine at each end. A 6-inch diaphragm 134 feet long battened with inch boards was set in the clay bed a depth of 2½ feet. At each end of this, 20 sheet-piles were then driven for greater security. The slopes were then constructed of sand and sandy loam, and the upper slope covered with about 15 inches of riprap, and the top with 12 inches of riprap of bowlders.

ROCK.

The necessary rock for Pine River Dam was collected around Cross Lake and along the river for a distance of 2½ miles below the dam. All the small rock were taken out along the river, and the large ones left in.

HEIGHT AND LENGTH OF DAM.

The dam is built for a 17-foot head above the low water of September 11, 1880, and is 1,500 feet long. The dam and dike together is 1,667 feet long. Of this length 235 linear feet is crib-work filled with rock.

The elevation of the floor above the sea-level is 1,218.196 feet. The elevation of the low water of September 11, 1880, was 1,219.696, and the elevation of the flowage line is 1,236.696.

RIPRAPPING BELOW LOG SLUICE.

During the spring of 1886, while logs to the amount of 44,000,000 feet, B. M., were passed through the log sluice, a hole 100 feet long, 60 feet wide, and 18 feet deep at the center, was formed by the scouring action of the heavy discharge through the sluice. It was oval-shaped, and had perpendicular walls 8 feet deep. The annual sluicing of logs would increase the scour, until eventually the dam would be undermined. To arrest its progress, the following work was commenced on October 7 and finished November 13.

The first work done was to fill around the mouth of the hole until a slope was formed and the depth at the center reduced to 12 feet. Then a large mat of brush, made of fascines 1 foot in diameter and 12 feet long, covering the entire area and containing 262 cubic yards, was sunk by loading it with manure and sand. The mat was constructed from the lower end by laying down a tier of fascines bound together by ropes; the second tier was laid so as to overlap half of the first tier, and so on until the upper end at the mouth of the log sluice was reached, the points of the brush being up-stream. The mat was then covered with large bowlders weighing from 500 to 2,800 pounds each, which were flat-boated in from Cross Lake and unloaded on the mat. Between the mouth of the hole and the north shore, the space was covered with brush, similar to the mat, and covered with small bowlders from 6 to 10 inches in diameter. This riprapping is about one foot thick. The work is now in good shape, and may never need any more work done there. If it does, there is some rock around Cross Lake and below the dam which can be easily got in.

The total amount of material put in place was as follows:

	Cubic yards.
Brush	391
Small bowlders	144
Large bowlders weighing from 500 to 2,800 pounds each	328

ESTIMATES OF WORK DONE AND MATERIALS PUT IN PLACE AT PINE RIVER DAM DURING ITS CONSTRUCTION.

Embankment, 13,967 cubic yards (8,698 cubic yards sand and sandy loam, 2,318 cubic yards clay and sand puddle wall, 616 cubic yards sod covering, 11,632 cubic yards embankment at dam, and 2,335 cubic yards embankment at dike):		
At 42½ cents per cubic yard, labor	$5,941.56	
Contingencies, at 18.5 cents per cubic yard	2,591.63	
Total (labor and contingencies, at 61.0+ cents per cubic yard)		$8,533.19
Excavation of foundation and for diaphragm (6,606 cubic yards):		
Labor, at 47.3 cents per cubic yard	3,129.33	
Contingencies, at 40.7 cents per cubic yard	2,692.13	
Total (labor and contingencies, at 88.1 cents per cubic yard)		5,821.46
Puddled clay and sand filling in trench and between and under caps (1,271 cubic yards):		
Labor, at 98.05+ cents per cubic yard	1,246.25	
Contingencies, at 59.1+ cents per cubic yard	751.36	
Total (labor and contingencies, at $1.571+ per cubic yard)		1,997.61
Concrete (80 cubic yards):		
Labor, at $5.828+ per cubic yard	466.28	
Material and contingencies, at $7.726 per cubic yard	618.08	
Total (labor, material, and contingencies, at $13.5545 per cubic yard)		1,084.36

ock, 6,272 cubic yards (3,534 cubic yards in crib-work; 682 cubic yards in boom piers; 166 cubic yards riprap above and below dam, and 472 cubic yards below log sluice; 289 cubic yards broken stone on slopes; 811 cubic yards riprap on embankment, and 318 cubic yards on dike):		
Labor, at $1.35+ per cubic yard	$8,481.06	
Contingencies, at 48+ cents per cubic yard	3,030.10	
Total (labor and contingencies, at $1.835+ per cubic yard)		$11,511.16
rush, 557 cubic yards:		
Labor, at $1.12 per cubic yard		627.40
ound piles in foundation, 749:		
Labor, at $2.926+ per pile	2,191.65	
Material and contingencies, at $3.731 per pile	2,795.08	
Total (labor, material, and contingencies, at $6.657+ per pile)		4,986.73
imber in dam, boom piers, and dike, 1,178,912 feet, B. M.:		
Labor, at $7.965+ per M feet, B. M	9,391.20	
Timber, iron, and contingencies, at $25.687 per M feet, B. M	30,283.80	
Total (labor, timber, iron, and contingencies at $33.65+ per M feet, B. M)		39,675.00
Sheet piles in dam, 1,943 (or 183,600 feet, B. M.):		
Labor, at $1.778+ per pile	3,456.39	
Material and contingencies, at $3.276+ per pile	6,366.14	
Total (labor, material, and contingencies, at $5.055 per sheet pile)		9,822.53
Summary of total sawed timber in dam (1,362,512 feet, B. M.) at $36.32+ for labor, material, and contingencies	49,497.53	
Coffer-dam, 688 linear feet (containing 176 round piles, 1,387 cubic yards of filling, and 133,504 feet, B. M.) at $12.92 per linear foot (including cost of removing the coffer-dam).	8,894.16	
Sawing timber, 1,728,046 feet, B. M., at $5.06 per M feet, B. M. (including cost of dismantling the saw-mill and removing the machinery a distance of 1,500 feet and building a house 20 by 34 feet over it)	8,732.58	
13 sets of gate machinery and 2 sets of castings for hoisting apparatus for log sluice	1,994.86	
Cost of freight, setting up, and boxes for covering gearing	797.88	
		2,792.74
Total cost of dam		86,852.18
Dam tenders, quarters, and stable	845.82	
Amount paid for damages to lands above the dam, United States district attorney's fees, surveys at and below dam, etc.	2,690.92	
		3,536.74
Grand total		90,388.92

In the above estimate of work done and materials put in place, the cost of the quarters, supplies, all temporary work, all materials purchased and all contingencies are charged to the units of work done and materials put in place in the dam and dike.

The total amount of iron purchased for the dam, not including the gate machinery, was 154,382.5 pounds. This is an average of 113.3 pounds per M feet, B. M., for all the timber put in place in the dam.

During the construction of the dam the laborers, as a rule, were paid $1 per day and their board. The cost of freighting from Brainerd to the dam was from 40 to 50 cents per 100 pounds. With proper management of the dam it ought to last fifteen years at least.

In conclusion I wish to acknowledge my indebtedness to A. O. Powell, assistant engineer, and Andrew McKenzie, master-laborer, for their valuable assistance in carrying on the work.

Very respectfully, your obedient servant,

ARCHIBALD JOHNSON,
Assistant Engineer.

CHAS. J. ALLEN,
Major of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 3, 1887.

SIR: The appropriation of August 5, 1886, for continuing operations upon the reservoirs at the headwaters of the Mississippi, having been made conditional upon the opinion of the Chief of Engineers that the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation, the views and opinions of the Board of Engineers were desired upon the effect of the reservoir discharges on the depth of water at and below Saint Paul, reported by Major Allen, and the advantages to navigation, if any, that they indicate as likely to accrue from a continuation of the operations projected.

I have the honor to submit herewith the report of the Board, dated May 24, made in compliance with these instructions, from which it will be seen that after patient and thorough investigation of the subject the Board concludes that the region already occupied by reservoirs is exceptionally well suited for the system, and the dams have accomplished all that was reasonably to be expected of them. They now adequately improve navigation in the sense that they render a fair return for their cost; and in the opinion of the Board they should be completed by raising the Pokegama Dam 2 feet and by building a dam in the Sandy Lake district, as recommended by Major Allen (in his project of November 5, 1886, herewith also submitted), if more elaborate surveys in that vicinity confirm present indications.

The Board does not favor the extension of the system to the St. Croix, the Chippewa, and the Wisconsin at present, believing that the funds applied to the bed of the river in contraction works, dredging the crests of the troublesome bars, etc., will yield better returns. That method has proved effective so far as applied to the Upper Mississippi, and it will be soon enough to consider the advisability of re-inforcing it by new reservoir systems when the necessity therefor has been demonstrated.

Concurring in these conclusions of the Board, it is my opinion that "the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation;" and I would recommend that Major Allen be instructed to proceed with the expenditure of the appropriation of $37,500 made in the river and harbor act of August 5, 1886, in the manner pointed out by the Board, and that his project of November 5, 1886, be approved.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT,
June 6, 1887.

Approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, *May* 24, 1887.

GENERAL: The Board of Engineers to which was referred, by De- artment indorsement of November 18, 1886, the communication of aj. C. J. Allen, Corps of Engineers, relative to a project for the appli- tion of $37,500, appropriated by river and harbor act of August 5, 86, for reservoirs at the headwaters of the Mississippi River, with a quest for the "views and opinions of the Board upon the effect of the servoir discharges on the depth of water at and below Saint Paul," tc., has the honor to submit the following report:

The improvement of low-water navigation upon the Upper Missis- ippi by means of artificial reservoirs constructed near its sources first ttracted attention shortly after the close of the war. Surveys to ob- ain the needful data were begun in 1866, and were prosecuted until 870 by General Warren. They were continued by Major Farquhar in 874, in connection with the examinations for transportation routes o the seaboard. In 1878 Congress made an appropriation for a still nore elaborate investigation, and Captain Allen was placed in charge f the work. The details of these preliminary examinations are pre- ented in the Annual Reports of the Chief of Engineers and in Ex- cutive documents of the Senate and House of Representatives. Finally, ongress inaugurated works of construction by act approved June 14, 1880.

GENERAL PROJECT FOR RESERVOIRS.

The general project contemplated the creation and maintenance of reservoirs upon the headwaters of the Upper Mississippi, the St. Croix, the Chippewa, and the Wisconsin, "for the purpose of regulating the volume of water and improving the navigation of said rivers and that of the Mississippi River." The proposed works in all comprised forty-one reservoir dams in Minnesota and Wisconsin, of which the estimated first cost (exclusive of land and damages) was $1,809,083.

THE EXISTING UPPER MISSISSIPPI SYSTEM.

Work was begun near the sources of the Mississippi, where the river traverses a plateau dotted with lakes and swamps, about 1,300 feet above the sea-level. The annual precipitation, although subject to great variation, averages at least 25 inches. Of the seven artificial dams proposed for this Upper Mississippi system four are now completed, viz, one on the main stream just below the efflux of Lake Winnibigoshish, 170 miles below Itasca Lake; another about 15 miles therefrom, in a southwesterly direction, where a considerable southern tributary, Leach Lake River, emerges from the largest natural lake of the region; another on the Mississippi River, about 30 miles in a straight line to the eastward, just above the Pokegama Falls. These three dams were completed in 1884. The fourth dam is on Pine River, just below Cross Lake, and discharges into the Mississippi about 190 miles below Pokegama Falls, at a point midway between Aitken and Brainerd. It was completed in 1886.

The Winibigoshish Dam, with a lift of 14 feet, creates a reservoir having a capacity of 40,000,000,000 cubic feet and requires twenty-six months to fill. The Leach Lake Dam raises the level of the lake 4 feet, and creates a reservoir having a capacity of 22,000,000,000 cubic feet, requiring twenty-four months to fill. The Pokegama Dam, with a lift of 7 feet, is capable of impounding 3,000,000,000 cubic feet, and requires from one to two months to fill. These three dams, all provided of course with sluices to regulate the outflow at will, are described in the Annual Report of the Chief of Engineers for 1883, page 1455. The fourth dam situated on Pine River creates a reservoir having a lift of 17½ feet, with a capacity for 7,000,000,000 cubic feet. It can be filled in one season. This dam is described in the Annual Report of the Chief of Engineers for 1886, page 1502.

The original project submitted by Captain Allen in his report upon his preliminary surveys, dated January 15, 1879 (Annual Report of the Chief of Engineers for 1879, page 1194), as already stated, provided for seven dams in this region—those above enumerated and three more—one on Leach River just below Mud Lake, one on the Mississippi below the mouth of the Vermilion River (both above Pokegama Falls) and one below the efflux of Gull Lake, discharging into the Mississippi through Crow Wing River. Major Allen for good reasons now proposes to dispense with the Mud Lake and Vermilion River dams by increasing the lift of the Pokegama Reservoir about 2 feet, at a cost of about $10,000, to dispense with the Gull Lake Reservoir on account of changed conditions now existing at that locality, and to create a comparatively inexpensive reservoir at Sandy Lake, 110 miles below Pokegama Falls, at a cost of about $12,000. The latter construction is urged not only to increase the available supply of water but also to prevent a temporary wasteful overflow into Sandy Lake when a large volume is released from the Pokegama Reservoir.

In fine, then, it appears that the original project for reservoirs upon the Upper Mississippi above Saint Paul has been essentially completed, or rather may be completed by the small additional outlay of $22,000. On June 30, 1886, the total outlay upon this system, including outstanding liabilities, had been $568,521.31. Major Allen considers that when completed as above indicated the works may be trusted to increase the discharge at points below as far down as the mouth of St. Croix River by 3,000 cubic feet per second for ninety days at the low stage.

The four reservoir systems—one essentially completed and three not yet begun—were designed, as already stated, (1) to improve the navigation of the Mississippi above Minneapolis and that of the three tributaries, and (2) to improve the navigation of the main river below Minneapolis. What has been accomplished will now be considered.

EFFECT ABOVE FALLS OF SAINT ANTHONY.

The Mississippi River between Pokegama Falls and the Falls of St. Anthony is naturally divided into two sections; that from the town of Grand Rapids (just below Pokegama Falls) to Aitkin, a distance of 165 miles; and that from Aitkin to the Falls of St. Anthony, a distance of 208 miles. The total distance from Grand Rapids to the Falls ofSt. Anthony is thus 373 miles.

The Northern Pacific Railroad touches the Mississippi River at Aitkin. Supplies to the lumbermen's camps and settlements above are rwarded by steam-boats plying between that town and Grand Rapls (165 miles). In 1886 three steamers were so employed, carrying ,500 tons of freight and 3,500 passengers. The river here has an avrage fall of about 6 inches to the mile and was originally crooked, narow, and obstructed by overhanging trees, snags, and bowlders, and lso by six rapids.

Congress, from time to time, beginning in 1874, has made appropriaions for the improvement of the Mississippi above the Falls of St. Anthony. Since 1880 all such funds have been applied to the removal f snags, bowlders, and leaning trees in this upper section, because the eeds of navigation here are much more urgent than below. The offier in charge, Major Allen, reports that the three completed reservoirs bove Grand Rapids may be relied upon, without any contraction works, o provide henceforward sufficient depth for boats navigating this porion of the river, and that funds for removing obstructions, as bowlders, tc., will alone be required. He found, experimentally in 1885, that he release of the retained water at the Pokegama Dam during the season of low water raised the level at Grand Rapids 5.2 feet, and at Aitkin 3 feet, the largest volume released being 3,200 cubic feet per second. Major Farquhar's original estimate for brush wing-dams, dredging, tc., to give a 5-foot navigable channel in this section, was $35,540 (Report of Chief of Engineers, 1875, page 452).

Between Aitkin and the Falls of St. Anthony (203 miles) the river at low water passes over a succession of ripples and rapids, dividing it into sixteen reaches. Major Farquhar's estimate for contraction works to give a 5-foot navigable depth, with four expensive locks and dams included, was $2,121,039. The extension of railroads has lessened the importance of steam-boat navigation in this section, and for the past six or seven years the boats have been removed. Should it ever become desirable to undertake the work of improvement, the increased supply of water now available from the reservoirs will, in Major Allen's opinion, render unnecessary most of the brush wing-dams and jetties estimated for in Major Farquhar's project.

In fine, then, the reservoirs have evidently had a very useful effect upon the Mississippi above the Falls of St. Anthony.

EFFECT BELOW FALLS OF SAINT ANTHONY.

Below St. Anthony's Falls the Mississippi River, in its natural condition, may be regarded as navigable; but large expenditures have been incurred by the Government for improvement by contraction works. In the upper section, above the mouth of the St. Croix River (45 miles), the natural flow is the smallest, and the difficulty of providing sufficient depth without unduly contracting the channel is consequently the greatest. Here, therefore, is to be expected the largest relief from the reservoir system above; and here the actual influence of existing reservoirs should receive the most careful study.

Such a study should include: (1) the character and results of the local works of improvement, both projected and constructed in the section under consideration; (2) the various gaugings of discharge and water-level records kept during the past twenty years at and near Saint Paul, to throw light upon the hydraulic conditions of the problem; and (3) the reservoir records kept by Major Allen in the years 1885 and 1886, during both of which the reservoirs were in actual operation.

Local works of improvement.—The corporate limits of Saint Paul and Minneapolis are adjacent to each other; the aggregate population is claimed to be 300,000; the shipments of flour during 1886 from Minneapolis aggregated 5,710,620 barrels. It is claimed that in early days 12,000 tons of freight were delivered at the Minneapolis landings, 1½ miles below the falls, during a single season, but the unimproved river to Saint Paul (13.5 miles) is so difficult of navigation that all heavy freight now goes by rail. Congress has donated 200,000 acres of land to aid in constructing a lock and dam at Meeker's Island (3 miles below the falls) to overcome about 17 feet fall; but no work has yet been done. Should this dam ever be built it will become necessary to fully improve the channel between Meeker's Island and Saint Paul, where as yet no work has been undertaken. Surveys, however, have been made showing approximately the fall in the first 3 miles below the falls to be 35 feet; in the next 5 miles 15 feet; and in the next 6½ miles 4 feet—all at a stage of about 4 feet on the Saint Paul gauge. The very great utility of a permanent increase in the low-water volume when attempting to improve such a channel needs no demonstration.

Saint Paul is situated at the present head of practical navigation of the Mississippi River. Thence to Hastings, just above the mouth of St. Croix River, a distance of 27 miles, the average slope is 0.53 feet per mile. Here the sum of $236,460 had been expended up to July 1, 1885, in improving the channel. This work in general consists of brush and stone dams and shore protections, designed to confine the low-water flow in a single channel having a uniform width adjusted to give the required depth. On July 1, 1883, the river at all stages below 4½ feet on the Saint Paul gauge, had been confined to a single channel; and the wing-dams for contracting the wider places were in process of construction. Evidently, when thoroughly regulated upon this system the channel will be in a condition to derive the maximum possible benefit from any increase in low-water discharge contributed by the reservoirs.

What increase in navigable depth has already resulted from the contraction works next demands attention.

General Warren records in his manuscript notes, for the report which unfortunately he was never to complete:

> By examination of the record of the gauge readings for the years 1867, 1868, and 1869, and part of 1866 (all that we have), in connection with the work of the dredge-boats and our knowledge of the condition of navigation in these seasons before they commenced to work, we find that when the water fell below 4 feet on the gauge at Saint Paul, boats drawing as much as 4 feet always found trouble in reaching Saint Paul.

Major Mackenzie has furnished the board with a valuable series of low-water records extending from 1868 to 1886, showing for the river between Saint Paul and the head of Lake Pepin (48 miles) the depth on the worst bars with corresponding Signal Service gauge readings at Saint Paul. To reduce these records to a common standard for comparison, this part of the river has been divided into ten sections, and for each the corresponding gauge reading at Saint Paul has been subtracted from all the recorded bar depths and the least remainder has been tabulated against that date. That this is a correct method of discussing the data and eliminating the slight oscillations of the water-surface for changes occurring after the river has established a fixed low-water regimen is shown by the records themselves, which in the reduced form above indicated are appended, marked A. The following list indicates how the different bars are divided between the ten sections:

Sec. 1. Frenchman's Bar; Pig's Eye Bar.
Sec. 2. Kaposia Bar; Red Rock Bars.
Sec. 3. Newport Bar; Merrimac Bar; Robinson's Bar.
Sec. 4. Pine Bend Bar; Grey Cloud Bars.
Sec. 5. Bonlanger Bar; Mininger Bar.
Sec. 6. Hastings Bars.
Sec. 7. Prescott Island Bars.
Sec. 8. Smith's Bars.
Sec. 9. Diamond Cliff Bars.
Sec. 10. Waconta Bar; head of Lake Pepin.

To exhibit these data to the eye, Plate I has been prepared. The average of the records in each section in any given season is assumed to represent what would have been the depth on its worst bar during that season had the water-surface at Saint Paul remained steadily at the zero of the Signal Service gauge (6 inches below that of the United States Engineer gauge).

Without claiming minute accuracy for this mode of discussion the plate exhibits very clearly the progressive improvement which Major Mackenzie has effected by his contraction works and differentiates that improvement from any beneficial reservoir effect. The latter (prospective) is indicated by the rise of water-surface (from 12 inches to 18 inches, as will appear below) which will probably be caused by adding 3,000 cubic feet per second to the normal discharge of the river at the zero stage.

This diagram indicates, in general terms, that the contraction works have already increased the navigable depth between Saint Paul and Lake Pepin, at low stages of the river, 18 inches and upward.

Hydraulic conditions and data.—No little labor has been devoted by the board to collecting all available data of this character at and near Saint Paul.

By far the most complete and valuable gaugings are those of General Warren, who in 1867 carried out a series extending from low to high water. The field work was performed by his assistant, Capt. J. P. Cotton, in a precise and thorough manner and the elaborate office reductions (which have been examined by the board) leave nothing to be desired. This material was left by General Warren at his death only partially discussed, and it has never been published. Antedating as it does all works of improvement, the data possess so exceptional a value that they are appended in full to this report (marked B), and are also exhibited to the eye on Plate II.

In 1881, after Major Mackenzie had materially improved navigation over the worst bars by his works of contraction, a party was sent by the Mississippi River Commission to gauge the discharge at Prescott, just above the mouth of the Saint Croix, where the results are directly comparable with observations at Saint Paul, 30 miles above. The data collected (Senate Ex. Doc. 32, Forty-seventh Congress, second session) covered about 6 feet of river oscillation, and are exhibited in Appendix B, and on Plate II.

From time to time during the progress of the reservoirs, single gaugings were made by the officer in charge. Various methods and different observers were employed and no special attention was given to exact accuracy in some of these measurements; but they are all included in Appendix B and on Plate II.

An inspection of Plate II suggests two important conclusions:

(1) That the improvement of the channel by contraction has somewhat reduced the absolute resistances to the flow, permitting a slightly

larger discharge at any given low stage. Exactly what is this increase can hardly be inferred, because recent systematic gaugings to compare with those of General Warren are lacking.

(2) That there has been no material change in the increments of discharge necessary to raise the water level 1 foot at the very low stages when navigation becomes difficult. In 1867 and 1881 this quantity varied so little as to warrant the adoption of the following mean scale of discharge in cubic feet per second at each stated foot of the United States Engineer gauge,* of which the zero (6 inches above that of the permanent pier gauge) is at the adopted low water of 1864 (lowest recorded).

Engineer gauge.	Discharge per second.	Increase.	Engineer gauge.	Discharge per second.	Increase.
	Cubic feet.	*Cubic feet.*		*Cubic feet.*	*Cubic feet.*
0	3,000	....	5	15,500	3,400
1	4,400	1,400	6	19,200	3,700
2	6,400	2,000	7	23,000	3,800
3	9,000	2,600	8	26,900	3,900
4	12,100	3,000			

These figures furnish the best attainable estimate for the average change in water service at Saint Paul, which will be caused by varying the volume at low stages. The Board adopts these figures as worthy of confidence, and Plate II will enable the scale to be extended to higher stages if desired.

---

* Gauge records have been kept at Saint Paul nearly continuously since General Warren began them in 1866, and the only difficulty connected with them is the certain intercomparison of zeros at different dates. This matter has been investigated carefully by the board and with the assistance of Major Mackenzie, Major Allen, Captain Cotton, and General Warren's old records, satisfactory comparisons have been reached. To preserve them for future use they are here recorded.

The bench-mark at Saint Paul, to which all gauges are referred, is the nose of the starling on the up-stream side of the shore pier of the highway (Wabasha street) bridge. This bench-mark is believed to have remained unchanged since General Warren began his observations.

On the second pier of the same bridge is a permanent gauge. Roman figures, each 1 foot high, with alternate blank spaces 1 foot high between them, are cut in the stone. General Warren personally wrote on the first record (September, 1866): "Mr. McCormack (the gauge-keeper) says the marks were put on the pier of the Saint Paul Bridge in the winter of 1863 and 1864 from the ice, by direction of the city authorities. It was, he believes, intended to indicate the low water of 1863 by the position of the zero. He thinks it was about as low in the autumn of 1863 as of 1864, and the lowest water ever known." Captain Cotton recorded (December 7, 1869) that the foot spaces were then "divided into four parts, painted alternately black and white; at each foot a small black dash is used; these occur opposite the center of the figures." Since that date the point has disappeared and some difference of opinion has arisen as to whether the top, the middle, or the bottom of the cut Roman figures were designed to mark the reading. This record of Captain Cotton, made in 1869, settles the question; the middle line should be used.

Unfortunately, General Warren's note-books leave some uncertainty as to the reference of the zero of this gauge to the bench-mark. This is of little importance, however, because it has since been well determined, as follows:

Assumed bench-mark on starling of pier		100,000
Top of figure XXI by Mr. Meigs, leveling on September 5, 1874, was	101,221	101,192
Same by Messrs. Johnson and Davenport, February 22, 1887	101,162	
Hence middle of figure XXI		100,692
Hence true zero of gauge		79,692

In other words, the zero of the permanent stone gauge is 20.308 feet below the bench-mark, and this was also the reference of the zeros of two temporary gauges used by

Test of the reservoirs in 1885 *and* 1886.—The season of 1885 was the irst in which work was sufficiently advanced to permit an actual operaion of the system; and only the three reservoirs above Pokegama Falls were then ready. The details of this trial are given by Major Allen in his report of December 18, 1885.

By the close of July 36,000,000,000 cubic feet of water had been impounded in the three reservoirs, without interfering with steam navigation between Grand Rapids and Aitkin.

On August 1 the outflow from the Pokegama Dam was 1,000 cubic feet per second, the average summer drainage, which, when the tributaries below are supplying their normal contributions, is sufficient for the needs of navigation above Aitkin. By August 10, the stage of water at Saint Paul being low and falling (United States Engineer gauge, 2.8 feet), the outflow was gradually increased until, by August 15, it reached 2,270 cubic feet; by September 16, 3,100 cubic feet, and by September 24, 3,200 cubic feet per second. On October 12 this outflow was reduced to 3,000 cubic feet, on October 20 to 2,600 cubic feet, and by the end of the month to 2,000 cubic feet per second.

Navigation having closed by November 12 the outflow was reduced to 800 cubic feet per second, a volume somewhat in excess of the normal winter drainage above Grand Rapids (less than 500 cubic feet).

Major Allen reports that the tributaries above Saint Paul were low and generally falling after the middle of August and that no material increase of water came from any source except the reservoirs. By actual measurement after the middle of September the Minnesota was discharging only 670 cubic feet; the Crow Wing, 1,316 cubic feet; the Platte, 156 cubic feet; the Sauk, 438 cubic feet; the Elk, 153 cubic feet; and the Crow, 228 cubic feet per second.

General Warren in his gaugings in 1867 and in his water-level records of 1869 (those of 1866, 1867, and 1868 were read directly on the permanent gauge). This zero is that of the plotted curves on diagram V in his report on "Bridging the Mississippi River", the only place where these records (although preserved) are published.

The Signal Service gauge was established at Saint Paul in 1872. It was first placed at the elevator (2,400 feet below the Wabasha Street Bridge). In 1875 it was moved to the steam-boat dock at Jackson street, 800 feet above. In 1885 the old gauge was replaced by a new one. The following levelings indicate that the zero of this gauge is practically the same as that of the permanent stone gauge, and that there have been no material variations since it was established.

Assuming bench-mark as 100, the zero of permanent second pier gauge is 79,692.

Signal Service zero (Meigs, 1874), 79,778; (Farquhar, 1874), 79,731; (Gillespie, 1879), 79,843; (Marr, 1882), 79,810; (Meigs, 1887), 79,799.

All readings of the Signal Service observers, therefore, refer to the same zero, and are directly comparable with General Warren's older records.

Colonel Farquhar (Annual Report of Chief of Engineers for 1878, page 704) states: "During the latter part of the summer and fall of 1877 occurred the lowest stage of water between Saint Paul and Acton since 1864. Under instructions from Colonel J. N. Macomb, the low water was marked at 61 stations and referred to permanent bench-marks. The low-water stage was about 9 inches higher than that of 1864."

In accordance with this determination the level of low water at Saint Paul in 1864 was adopted as half a foot above the zero of the Signal Service gauge; and a gauge known as the United States Engineer gauge is now maintained near the latter, but it is not read continuously. By the levels of Mr. Marr, in 1882, its zero reads 80,274, the bench-mark on starling of bridge pier being 100.

This arbitrary level for the low water of 1864 (half a foot above the zeros of the permanent pier gauge and of the Signal Service gauge) has been used by the Board in the following discussions, because it has been adopted by Colonel Macomb, Colonel Farquhar, and Major Mackenzie, successively in charge of the works of improvement. Whether the determination is absolutely more correct than the level of the zero of the permanent gauge, respecting which General Warren records shortly after its occurrence, "From all the evidence we were able to obtain we concluded that the zero of this gauge was the low water of 1864," is very doubtful.

The increment to the normal flow at Grand Rapids, due to the reservoirs at any date, is estimated by Major Allen as the excess of the actual discharge there over 1,000 cubic feet per second, that being the normal summer drainage from the region above. From the middle of August to the middle of October the increased flow due to the reservoirs therefore averaged fully 2,000 cubic feet per second, but it requires from fifteen to twenty days for water liberated at the Pokegama Dam to affect the volume at Saint Paul, 390 miles below (Annual Report of Chief of Engineers, 1880, page 1594). Hence, in 1885, it is during the months of September and October that the beneficial effects on navigation between Saint Paul and the St. Croix River is to be traced.

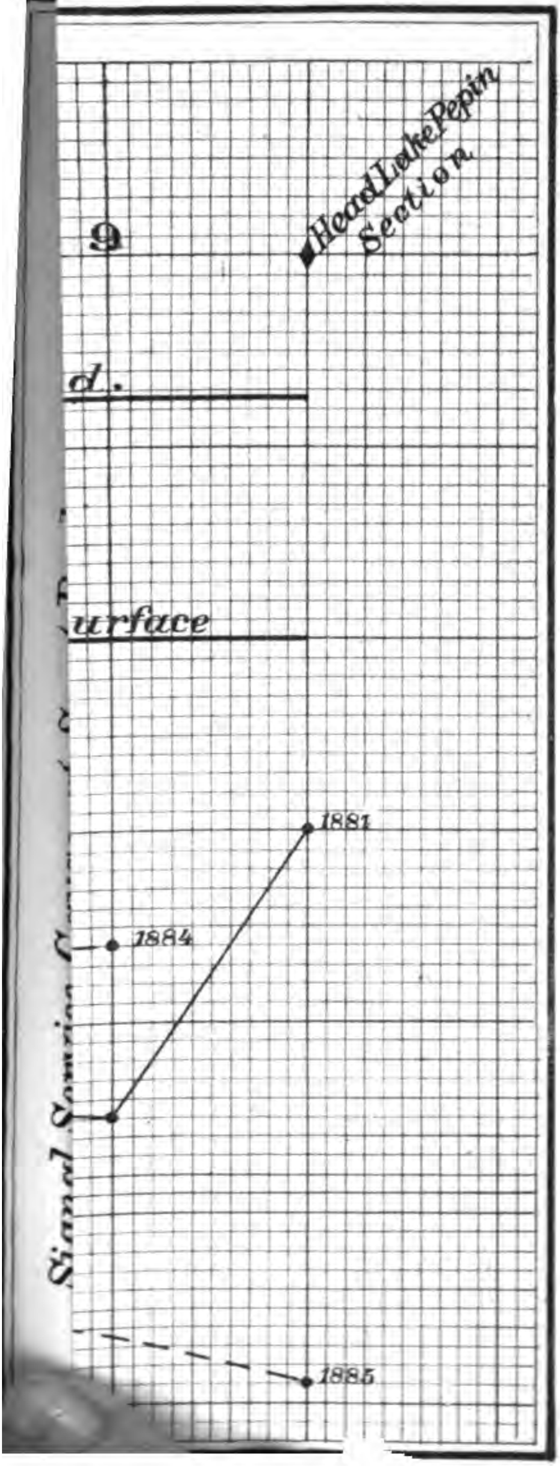
Gauge readings alone at Saint Paul afford an uncertain standard by which to measure this effect. The stage there depends (1) upon the natural drainage from a basin over 35,000 square miles in extent, where the downfall is subject to great variations from year to year, and (2) upon how the private logging dams upon many of the tributaries happen to be operated in the interest of their owners. These dams exist in large numbers and are supposed to control the drainage of not less than 3,000 square miles. Hence it is not safe to compare too closely the gauge readings at Saint Paul in different years with a view to deduce the beneficial influence of the reservoirs. Still, a comparison of the annual curves for the past eight years (Plate III) certainly suggests that this effect in 1885 probably equaled the difference in mean stages for September and October, in 1879 and 1885 (1.42 feet), less the difference between the mean July stages of these years (0.46 feet), or say about 0.96 feet, for increase due reservoirs.

The same computations at Hastings (27 miles below Saint Paul and just above the mouth of the Saint Croix) gives: Difference in mean stage for September and October, in 1879 and 1885 (1.20 feet), less the difference between the July means of those years (0.33 feet), or 0.87 feet, as the increase due to the reservoirs. At Winona (125 miles below Saint Paul) the same computation gives 1.39 — 1.33 = 0.06 feet, *i. e.*, the effect was practically *nil*, as indeed is naturally to be expected.

A like result is reached by another and more rigid mode of reasoning. The regular and equable addition of 2,000 cubic feet per second to the discharge at Pokegama Falls for a period of sixty days implies a nearly equivalent increase at Saint Paul, because this increase to the flow will sensibly increase the normal loss by evaporation and infiltration only by that due to increased width of channel. Five per cent. of loss from this cause, a large estimate, is only 100 cubic feet per second, which is quite within the probable error of the measured outflow. Hence it is safe to assume that if the reservoirs had not been acting in 1885, about 2,000 cubic feet per second less water would have passed Saint Paul during September and October than actually did pass. But the mean U. S. engineer gauge-reading for September being 2.96, and for October 2.69 (mean, 2.82) the foregoing scale of discharge indicates that the water surface would have stood .8 foot lower than it actually did stand, a result which compares well with the gauge computation above.

The reservoirs were again operated to assist navigation during the season of 1886, which was exceptionally unfavorable by reason of long and extended droughts throughout the basin. The three dams above Grand Rapids were operated to increase the volume for a longer period than in 1885, but the flow per second was not so great. The discharge

PLATE I


9
Head Lake Pepin Section
d.
urface
1881
1884
1885
Signal Service

GAUGE-READINGS AND NAVIGABLE DEPTHS ON THE BARS.

It is well known that in rivers with sandy beds, like the Upper Mississippi below Saint Paul, changes in gauge-readings are not always or usually followed by corresponding changes in navigable depth. Any change, whether a rise or a fall, may temporarily disappoint expectations, the former by moving sand and filling up the best existing channels before the current has had time to excavate new ones in the new positions demanded by the changed hydraulic conditions; and the latter by excavating existing channels still deeper under the increased velocity caused by the contraction of the general cross-section from the subsidence of the water surface. (Any such apparent improvement may, however, be soon more than neutralized by the draining of the pools above the bar.) These apparently anomalous results are expressed in river parlance by the saying that "the bottom rises and falls with the water surface." It is unquestionably true that on such rivers *a long continuance of a uniform gauge reading* is favorable to navigation, and that the higher this reading is at low stages the better is the navigation. But this is precisely the effect of the reservoirs, which by the aid of the telegraph may always be operated to equalize as well as to increase the flow at Saint Paul. As far down as the mouth of the first considerable tributary, the Saint Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the Saint Paul gauge, *i. e.*, from 1 foot to 18 inches at low-water stages.

Below the mouth of the Saint Croix the effect must rapidly diminish, because the normal low-water discharge is constantly increased by the contributions of the tributaries and *the percentage* added by the reservoirs grows constantly less and less. General Warren (Senate Ex. Doc. 58, Thirty-ninth Congress, second session, page 32) states that when his low-water measurements gave a discharge at Saint Paul of 8,000 cubic feet, the Saint Croix added 2,000 cubic feet, the Cannon 600 cubic feet, the Chippewa 2,300 cubic feet, and the Zumbro 600 cubic feet per second. At this latter point (105 miles below Saint Paul) the contributions of these rivers and of the other smaller tributaries had swelled the discharge to 18,000 cubic feet. The gaugings of the Mississippi River Commission in 1881 (Annual Report of Chief of Engineers for 1881, page 2,742) confirm this estimate and give for the discharge at localities hydromatrically the same as General Warren's (Prescott and Winona) when the river was 3.21 feet above low water, 8,598 cubic feet and 17,712 cubic feet. These accordant results indicate that the normal discharge of the river below Saint Paul is increased quite rapidly by the contributions of the tributaries; and the Board concurs with Major Allen in his opinion that no material benefit below Lake Pepin is to be expected from the existing system of reservoirs.

In fine, then, the facts warrant the conclusion that the existing reservoir system "adequately improves navigation" for about 30 miles below Saint Paul, where the natural difficulties are greatest and where no other method of open-channel improvement can be certainly trusted to afford the needed depth, unless supplemented by an increased volume of discharge.

FURTHER EXTENSION OF THE SYSTEM.

To extend this method of improvement to the river below the mouth of the St. Croix, it will be necessary to carry out the original project of constructing systems of reservoirs upon the St. Croix, the Chippewa, and the Wisconsin. Before undertaking such work the subject demands grave consideration. Although preliminary surveys were made and dams were approximately projected, no steps have yet been taken committing the Government to the work. It is now to be noted:

(1) That the extension of railroads since 1879, and the rapid development of the country, has materially changed the conditions then existing in the reservoir regions of Wisconsin; in one instance a flourishing railroad town (Rhinelander) has sprung up near the site of one of the projected reservoirs. The cost of land damages (not included in the original estimates for reservoirs because too uncertain to admit of precision) has therefore been enhanced and in some instances very materially so since the surveys were made.

(2) Experience with the works already constructed has shown that troublesome claims for damages from overflowed lands must be expected. Much of the land overflowed by the existing reservoirs belongs to the United States; other portions belong to the Indian reservations; others originally belonged to the State of Minnesota, but were released to the United States by an act of the legislature in 1881; and considerable areas of private land above the Pokegama Falls were also voluntarily released by their owners. Still, claims that the wild rice and hay crops on the Indian reservations have been injured have been made, and an Indian commission has awarded damages. Further unsettled claims of this character still exist.

(3) So long as the lumber of the region remains valuable logging will interfere with the reservoir system in two ways—first, by creating private dams for local objects which interfere with the regular contribution of the tributaries below the Government dams (probably 100 such dams now exist above the Falls of St. Anthony); and, second, by compelling a wasteful use of water at the Government reservoirs in order to pass the logs as they arrive. Major Allen suggests that both these causes of interference now require legislation.

(4) The dams when completed have to be kept in repair and guarded at considerable annual outlay. Major Allen estimates for simple maintenance about $3,000 yearly for each dam; and no trustworthy data for estimating the annual cost of repairs have yet been collected, the construction being still too new.

For these and other reasons the further extension of the system of improving low-water navigation by reservoirs in this region is not recommended by the Board. The method is economically applicable only in districts where the land has little value and where the population is small; it necessarily interferes with private interests in a settled region and the larger the population the more serious is the interference.

PRACTICAL OPERATION OF THE RESERVOIR SYSTEM.

Experience has already convinced Major Allen (Annual Report of Chief of Engineers for 1886, page 1,504) that further legislation is necessary to protect the reservoirs now in use, and their regulation in the interests of navigation.

Nearly all of the tributaries to the Mississippi River above Minneapolis are incumbered either by "gate-dams" or by "cut-away dams." The latter are usually built in the spring, with a head of 2 or 3 feet, and are cut away for the passage of logs at such times as suits the convenience of the lumbermen. The "gate-dams" are permanent structures, erected for the same object, sometimes with a head as high as a dozen feet. The collection of water begins about the 1st of September, and sometimes much earlier, with a view to log-driving in the following April, May, and June. These dams multiply rapidly and seriously interfere with the Government operations in the interests of navigation. Another difficulty arises from the urgent pressure to pass logs through the Government sluices at times when such action involves needless waste of water.

Both of these difficulties result from lack of system and co-operation among the loggers; indeed, logs are now driven in every month in the year when the river is open. Major Allen considers that special legislation is desirable, placing the control of the operating of the reservoirs permanently in the hands of the War Department, and providing that logs shall not be sluiced through reservoir dams before August 1, and then only during a period of forty days. Also that it should be made unlawful, with severe penalties prescribed, (1) for individuals or corporations to prevent water from flowing into any Government reservoir or into the Mississippi above Minneapolis without the consent of the War Department; and (2) for any individual or corporation to open any sluice or cause any malicious injury to any part of the Government works.

The Board concurs in these views of Major Allen. Large expense has been incurred to benefit navigation by this plan, and individual interests should not be allowed to interfere with the efficient working of the system.

RECOMMENDATIONS OF THE BOARD.

The region already occupied by reservoirs is exceptionally well suited for the system, and the dams have accomplished all that was reasonably to be expected from them. They now "adequately improve navigation" in the sense that they render a fair return for their cost; and in the opinion of the Board they should be completed by raising the Pokegama Dam 2 feet and by building a dam in the Sandy Lake district, as recommended by Major Allen, if more elaborate surveys there confirm present indications.

The Board does not favor the extension of the system to the St. Croix, the Chippewa, and the Wisconsin at present. It is believed that funds applied to the bed of the river in contraction works, dredging crests of troublesome bars, etc., will yield a better return. That method has proved effective so far as applied to the Upper Mississippi, and it will be soon enough to consider the advisability of re-inforcing it by new reservoir systems when the necessity therefor has been demonstrated.

The Board recommends that the legislation suggested by practical experience in operating the reservoir system, and stated above, be requested from Congress.

The Board further recommends that such gaugings be made at or near Saint Paul during the annual operation of the reservoirs as shall determine accurately the discharge at that point at critical periods. These data, together with the known volumes contributed by the reservoirs, and the meteorological and water-level records now regularly kept, will permit a further discussion of the subject should it ever become desirable to extend the system to the lower tributaries.

Two appendices (A and B) and three plates (I, II, and III) accompany this report.

The papers referred to the Board in connection with this subject are returned herewith. * * *

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel of Engineers.
HENRY L. ABBOT,
Col. of Engineers, Bvt. Brig. Gen.
D. C. HOUSTON,
Lieut. Col. of Engineers, Bvt. Col.
WALTER McFARLAND,
Lieut. Col. of Engineers.
W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPEN

Depth on worst bars between Saint Paul and

Year.	Section 1.			Section 2.			Section 3.			Section 4.			Section 5.		
	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.
1868	July 12	3.2	3.0	July 12	3.2	3.5	July 31	3.8	4.5	July 12	3.2	2.7	July 12	3.2	3.5
	July 14	3.5	3.0							July 15	3.5	3.5	July 18	3.7	4.2
	July 20	3.9	3.7							July 18	3.7	4.0	July 25	3.9	4.0
	July 25	3.9	4.0							July 20	3.9	3.5	July 30	3.9	4.0
	July 30	3.9	4.0							July 25	3.9	4.0	Aug. 3	3.7	3.5
	Aug. 3	3.7	3.5	Aug. 6	3.4	3.5				July 27	3.9	3.5	Aug. 10	3.0	3.4
	Aug. 8	3.2	3.0							July 30	3.9	3.7	Aug. 17	3.5	3.5
	Aug 10	3.0	3.5							July 31	3.8	3.7	Aug. 22	3.8	4.0
	Aug. 12	3.4	3.7							Aug. 3	3.7	3.5	Aug. 24	3.8	3.5
	Aug. 17	3.5	3.5							Aug. 6	3.4	3.4	Aug. 27	3.5	3.2
	Aug. 22	3.8	3.5							Aug. 10	3.0	3.5			
	Aug. 24	3.8	3.5							Aug. 12	3.4	3.5			
	Aug. 28	3.3	2.7							Aug. 15	3.4	3.7			
										Aug. 17	3.5	3.5			
										Aug. 22	3.8	3.5			
										Aug. 24	3.8	3.5			
										Aug. 28	3.3	3.0			
										Aug. 29	3.0	3.0			
1873	Sept. 27	3.1	2.8												
	Oct. 1	3.3	3.0												
	Oct. 17	3.2	3.5												
1874													Oct. 25	3.4	3.0
													Oct. 27	3.4	3.5
1875							Aug. 12	2.7	2.5	Aug. 12	2.7	3.2–			
1876	Oct. 7	3.6	reached Saint Paul with 3.'2 draught.												
1877	June 29	to July 3.1, gauge 6.'1 down to 3.'4, reached Saint Paul with 3.'2 draught.													
	Aug. 1	3.3	Aug. 1, 3.3 3.2 bad. Aug. 1, 3.3 3.2 bad.												
1878	July 29	3.7	reached Saint Paul with 3.'2 draught.												
1879	July 2	5.3	reached Saint Paul with 3.'2 draught easily.												
1880	July 29	4.0	reached Saint Paul with 3.'2 draught.												
1881	July 16	6.2	6.0	July 16	6.2	6.5	July 16	6.2	7.0	July 16	6.2	7.0	July 15	6.2	7.5
	July 23	5.8	4.0	July 23	5.8	8.5	July 25	5.7	5.0	Aug. 7	3.9	4.0	Aug. 7	3.9	5.5
	July 25	5.7	5.0	July 25	5.7	6.5	Aug. 7	3.9	5.0	Aug. 9	4.0	4.0	Aug. 12	3.7	6.5
	Aug. 7	3.9	3.5	Aug. 7	3.9	5.0	Aug. 9	4.0	5.5	Aug. 12	3.7	4.0			
	Aug. 9	4.0	3.5												
1882	July 31	5.8	less than 4.0		3.1	Diamond Jo boats, draught 3.'0, went through: no very low-									
	Aug. 28	7.9	7.5												
1883	Sept.	1.9	reached Saint Paul with 2.'7 draught.												
1884	Aug. 8	2.4	3.2–				Aug. 8	2.4	4.0	Aug. 8	2.4	3.0	Aug. 8	2.4	3.5
										Aug. 12	2.4	3.0			
		3.0	Centennial (largest on river), draught 4.'0, reached Saint Paul.												
		2.4	Barnard, draught 3.'2, reached Saint Paul.												
		2.9	Diamond Jo boats, draught 3.'0, reached Saint Paul without trouble.												
1885	Sept. 2	3.1	5.0	Sept. 2	3.1	4.'5	Sept. 2	3.1	5.0	Sept. 2	3.1	4.0	Sept. 1	3.1	6.0
													Sept. 2	3.1	5.0
		2.7	Barnard, draught 3.'2, reached Saint Paul.												
		2.4	Diamond Jo boats, draught 3.'0 reached Saint Paul without trouble.												
		3.0	War Eagle, draught 3.'5 (light), reached Saint Paul without trouble.												
1886	Aug. 14	2.0 1.2	3.2–	Aug. 14	2.0 1.2	3.2–	Aug. 14	2.0 1.2	3.0	Aug. 18	2.0	4.0	Aug. 14	2.0 1.2	3.5
	Aug. 17	2.0	3.5	Aug. 15	1.2	3.2	Aug. 15	1.2	3.5				Aug. 18	2.0	3.5
				Aug. 17	2.0	3.2	Aug. 17	2.0	4.0						
		1.1	Barnard, draught 3.'2, reached Saint Paul.												
		2.5	White Eagle, draught 4.'0, went down river.												
		2.6	War Eagle, draught 3.'5 (light), reached Saint Paul.												

DIX A.

Lake Pepin 1868 *to* 1886.

Section 6.			Section 7.			Section 8.			Section 9.			Section 10.		
Date.	S. S gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.
			July 12	3.2	3.7									
			July 18	3.7	4.2									
			Aug. 6	3.4	3.0									
			Aug. 10	3 0	3.7									
			Aug. 13	3.5	4.0									
			Aug. 15	3.4	4.0									
			Aug. 22	3.8	3.7									
			Aug. 27	3.5	3.7									
Oct. 16	3.1	very shoal water			3.1									
Aug. 1	3.3	3.2	bad. Aug. 1, 3.3, 3.2, bad.											
						Aug. 26	1.7	turned back with draught.			3.'2			
						Sept. 26	1.3	turned back with draught.			3.'2			
Oct. 2	2.0	turned back with 3.'2 draught.												
July 14	6.0	7.0	July 14	6.0	6.5	July 14	6.0	8.0	Aug. 6	4.0	6.5	July 14	6.0	7.0
			July 23	5.8	5.0	Aug. 6	4.0	7.0						
			Aug. 6	4.0	4.5	Aug. 13	3.7	6.0						
water in 1882.														
Aug. 8	2.4	5.0	Aug. 8	2.4	4.0				Aug. 8	2.4	4.0			
Sept. 1	3.1	6.0										Sept. 1	3.1	7.0

NOTE.—Mills at Minneapolis affected gauge on Aug. 14, 15, and 16.

Depth on worst bars between Saint Paul and

GENERAL AVERAGE OF ABOVE

Year.	Section 1.			Section 2.			Section 3.			Section 4.			Section 5.		
	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.
1868..		3.5	3.4		3.3	3.5		3.8	4.5		3.6	3.5		3.6	3.7
1873..		3.2	3.1											3.4	3.2
1874..															
1875..								2.7	2.5		2.7	3.2−			
1876..		3.6	3.2+		3.6	3.2+		3.6	3.2+		3.6	3.2+		3.6	3.2+
1877..		3.3	3.2+		3.3	3.2		3.3	3.2		3.3	3.2+		3.3	3.2+
1878..		3.7	3.2+		3.7	3.2+		3.7	3.2+		3.7	3.2+		3.7	3.2+
1879..		5.3	3.2+		5.3	3.2+		5.3	3.2+		5.3	3.2+		5.3	3.2+
1880..		4.0	3.2+		4.0	3.2+		4.0	3.2+		4.0	3.2+		4.0	3.2+
1881..		5.1	4.4		5.4	6.6		4.9	5.6		4.4	4.7+		4.6	5.5
1882..		6.8	5.7		3.1	3.0+		3.1	3.0+		3.1	3.0+		3.1	3.0+
1883..		1.9	2.7+		1.9	2.7+		1.9	2.7+		1.9	2.7+		1.9	2.7+
1884..		2.4	3.2−		2.7	3.4+		2.4	4.0		2.4	3.0		2.4	3.5
1885..		3.1	5.0		3.1	4.5		3.1	5.0		3.1	4.0		3.1	5.5
1886..		1.7	3.4		2.1	3.2		2.1	3.5		2.0	4.0		1.7	3.5

Pepin **1868** *to* **1886.—Continued.**

EACH SEASON.

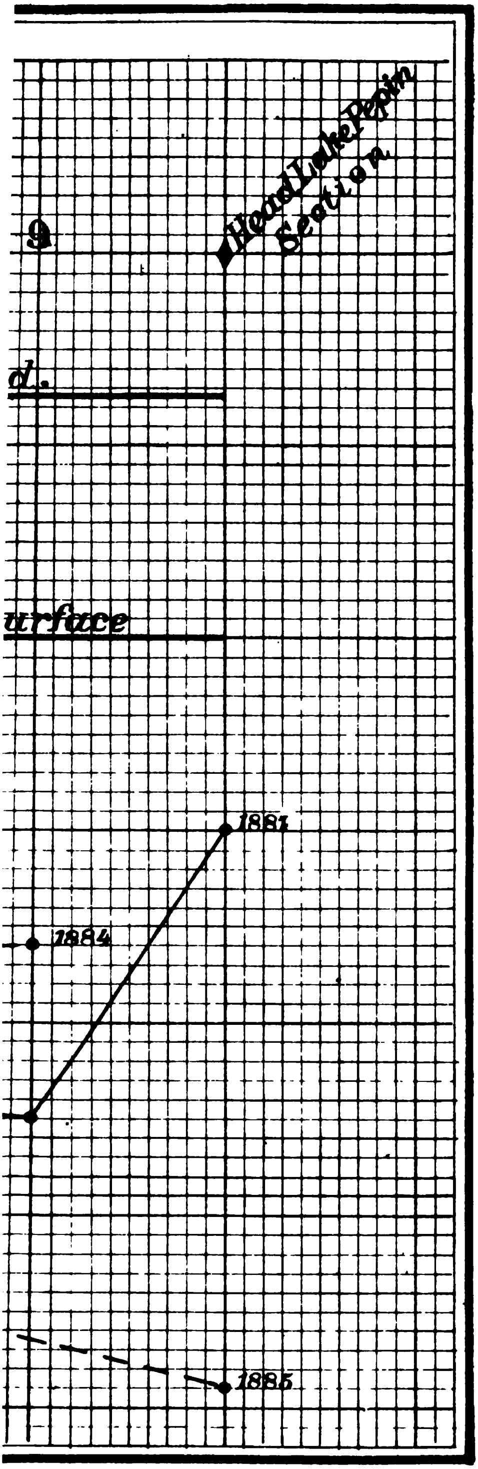
Section 6.			Section 7.			Section 8.			Section 9.			Section 10.		
	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.	Date.	S. S. gauge Saint Paul.	Depth on bar.
				3.4	3.8									
	3.1	3.2		3.1	3.2		3.6	3.2+		3.6	3.2+		3.6	3.2+
	3.3	3.2		3.3	3.2		3.3	3.2+		3.8	3.2+		3.8	3.2+
	3.7	3.2+		3.7	3.2+		3.7	3.2+		3.7	3.2+		3.7	3.2+
	5.3	3.2+		5.3	3.2+		5.3	3.2+		5.3	3.2+		5.3	3.2+
	4.0	3.2+		4.0	3.2+		4.0	3.2+		4.0	3.2+		4.0	3.2+
	6.0	7.0		5.3	5.3		4.6	7.0		4.0	6.5		6.0	7.0
	3.1	3.0+		3.1	3.0+		3.1	3.0+		3.1	3.0+		3.1	3.0+
	1.9	2.7+		1.9	2.7+		1.9	2.7+		1.9	2.7+		1.9	2.7+
	2.4	5.0		2.4	4.0		3.0	4.0+		2.4	4.0		3.0	4.0+
	3.1	6.0		2.4	3.0+		2.4	3.0+		2.4	3.0+		3.1	7.0
	1.1	3.2+		1.1	3.2+		1.1	3.2+		1.1	3.2+		1.1	3.2+

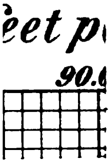
APPENDIX B.

Gaugings at Saint Paul.

Authority.	Date.	U. S. Engineer gauge at Saint Paul.	Discharge per second.	Remarks.
	1866.		*Cu. ft.*	
Gen. Warren	Sept. 24	2.4	6,000	By meter.
	1867.			
Do......	June 15	15.5	71,884	By floats.
Do......	June 22	12.7	54,220	Do.
Do......	June 26	14.0	64,892	Do.
Do......	July 1	16.5	88,014	Do.
Do......	July 5	14.5	71,751	Do.
Do......	July 8	13.0	58,992	Do.
Do......	July 10	12.1	52,063	Do.
Do......	July 12	11.1	45,210	Do.
Do......	July 15	9.7	35,914	Do.
Do......	July 17	9.0	34,183	Do.
Do......	July 20	14.7	73,150	Do.
Do......	July 22	17.5	117,450	Do.
Do......	July 23	18.0	110,552	Do.
Do......	July 27	16.2	89,725	Do.
Do......	July 31	14.2	65,186	Do.
Do......	Aug. 5	12.2	52,776	Do.
Do......	Aug. 10	10.0	35,858	Do.
Do......	Aug. 14	9.0	32,850	Do.
Do......	Aug. 20	7.9	26,719	Do.
Do......	Aug. 23	7.3	23,541	Do.
Do......	Aug. 29	5.9	18,355	Do.
Do......	Sept. 4	5.0	15,414	Do.
Do......	Sept. 13	4.0	9,316	Do.
Do......	Sept. 14	3.9	10,055	Do.
Do......	Sept. 16	4.1	10,156	Do.
Do......	Sept. 18	4.1	10,700	Do.
Do......	Sept. 20	4.6	12,460	Do.
Do......	Sept. 21	4.6	12,960	Do.
Do......	Sept. 23	4.6	11,892	Do.
Do......	Sept. 25	4.3	11,784	Do.
Do......	Sept. 26	4.2	11,110	Do.
Do......	Sept. 27	4.1	11,697	Do.
Do......	Sept. 28	4.0	11,000	Do.
Do......	Sept. 30	3.9	10,357	Do.
Do......	Oct. 1	3.7	10,274	Do.
Do......	Oct. 2	3.7	10,032	Do.
Do......	Oct. 3	3.6	9,818	Do.
Do......	Oct. 5	3.5	9,708	Do.
Do......	Oct. 8	3.6	9,870	Do.
Do......	Oct. 9	3.5	9,783	Do.
Do......	Oct. 10	3.5	9,636	Do.
Do......	Oct. 12	3.3	9,270	Do.
Do......	Oct. 14	3.2	8,921	Do.
Do......	Oct. 17	3.1	8,853	Do.
Do......	Oct. 19	3.0	8,528	Do.
Do......	Oct. 21	3.0	8,282	Do.
Do......	Oct. 23	3.0	8,267	Do.
Do......	Oct. 25	2.9	8,108	Do.
Do......	Oct. 26	2.9	8,046	Do.
Do......	Oct. 28	2.8	7,816	Do.
Do......	Oct. 30	2.9	8,440	Do.
Do......	Oct. 31	2.8	8,122	Do.
Do......	Nov. 1	2.8	8,317	Do.
Do......	Nov. 2	2.8	8,455	Do.
Do......	Nov. 4	3.0	8,906	Do.
Do......	Nov. 6	2.9	8,625	Do.
Do......	Nov. 7	2.9	8,712	Do.
Do......	Nov. 9	2.9	8,654	Do.
Do......	Nov. 11	2.9	8,601	Do.
Do......	Nov. 12	2.8	8,412	Do.
Do......	Nov. 13	2.8	8,402	Do.
Do......	Nov. 14	2.8	8,331	Do.
Do......	Nov. 15	2.8	8,293	Do.
Do......	Nov. 18	2.9	8,217	Do.
Do......	Nov. 19	2.7	8,103	Do.
Do......	Nov. 20	2.7	7,987	Do.
Do......	Nov. 21	2.7	8,075	Do.
	1867.		*Cu. ft.*	
Gen. Warren	Nov. 22	2.9	8,229	By floats.
Do......	Nov. 23	2.7	8,073	Do.
Do......	Nov. 25	2.6	7,877	Do.
Do......	Nov. 26	2.6	7,742	Do.
Do......	Nov. 27	2.6	7,560	Do.
	1868.			
Do......	Mar. 4	1.9	4,400	By meter under ice 2 feet thick.
Do......	Mar. 6			
Do......	Mar. 10			
Do......	Mar. 13			
Do......	Mar. 19	5.2	9,564	By meter under ice 1.3 feet thick.
Do......	Mar. 20			
Do......	Mar. 21			
Do......	Mar. 27	6.4	19,156	By meter.
Do......	Aug. 28	2.5	8,380	Do.
Do......	Oct. 10	3.3	10,249	Do.
	1881.			
Mississippi R. Com.	July 22	5.5	21,832	By staff rods.
Do......	July 26	5.2	17,026	Do.
Do......	July 27	4.9	16,483	Do.
Do......	July 28	4.7	16,455	Do.
Do......	July 29	4.5	15,637	Do.
Do......	Aug. 2	3.8	12,889	Do.
Do......	Aug. 3	3.6	11,963	Do.
Do......	Aug. 4	3.5	11,148	Do.
Do......	Aug. 5	3.5	10,812	Do.
Do......	Aug. 10	3.4	11,061	Do.
Do......	Aug. 12	3.3	10,937	Do.
Do......	Aug. 15	2.8	8,533	Do.
Do......	Aug. 16	3.0	9,001	Do.
Do......	Aug. 17	2.9	9,380	Do.
Do......	Aug. 18	3.3	9,899	Do.
Do......	Aug. 19	3.4	10,762	Do.
Do......	Aug. 22	4.1	13,312	Do.
Do......	Aug. 23	4.2	13,835	Do.
Do......	Aug. 24	4.2	12,932	Do.
Do......	Aug. 25	4.1	12,497	Do.
Do......	Aug. 29	4.3	12,890	Do.
Do......	Aug. 31	4.8	13,347	Do.
Do......	Sept. 8	5.8	17,115	Do.
Do......	Sept. 13	8.8	35,620	Do.
Do......	Sept. 14	9.0	37,047	Do.
Do......	Sept. 19	9.1	35,512	Do.
Do......	Sept. 20	9.2	37,536	Do.
	1874.			
Col. Farquhar.	Sept. 3	5.8 (?)	20,091	
Do......	Sept. 25	4.3 (?)	15,332	
Do......	Sept. 28	4.3 (?)	15,516	
	1878.			
Maj. Allen.	Oct. 22	1.3	6,218	
	1879.			
Do......	Mar. 27	1.8	4,307	By floats.
Do......	Mar. 28	0.9	4,104	Do.
	1880.			
Do......	June 9	10.5	46,512	Do.
	1884.			
Do......	Aug. 23	2.4	8,075	By staff rods.
	1885.			
Do......	Sept. 26	3.1	9,040	Do.
Do......	Oct. 9	2.6	8,218	By meter.
Do......	Nov. 18	2.1	6,466	By staff rods.
Do......	Nov. 23	1.9	5,523	Do.
Do......	Nov. 28	1.5	5,376	Do.
	1886.			
Do......	Aug. 3	1.9	6,923	By meter.
Do......	Aug. 14	1.5	6,866	
Do......	Aug. 18	1.5	5,624	Do.

PLATE I




eet p
90.

RS GAUGE

AUL

N.

ıst

20 1

A A 5.

IMPROVEMENT OF CHIPPEWA RIVER, WISCONSIN.

is improvement consists in the construction of dams and jetties to ne the low-water volume to a practicable channel, and in revet- of caving bends, between Eau Claire and the mouth of the river, tance of 57 miles.

e general plan of improvement was adopted in 1877, and the work)een carried on in accordance with it, varying, however, more or ss to location and extent of dams, jetties, etc.

e examination of the river upon which this improvement is based nade in 1874, and the results thereof reported January 30, 1875 pages 375–380, Part I, Annual Report of Chief of Engineers, 1875). estimated cost of improvement from Eau Claire to the mouth of river, based upon that report, summed up $139,892.50, of which .02.50 was estimated as the cost of protecting the Yellow Banks. protection of these banks has since been made a separate work. icting this item, therefore, the estimate for improving the chan- alone, by means of brush and stone dams, jetties, and revetment ving bends, is reduced to $75,790.

e revised estimate (see page 1440, Appendix X, Annual Report of f of Engineers for 1883) for the cost of this work, however, brought from $75,790 to $132,476.35, including in this figure all the expend- s from the commencement of the improvement.

e work during the past fiscal year, under the appropriation of 50 by act of Congress approved August 5, 1886, and the balance former appropriations, consisted in the construction of a dam at Claire of piling, brush, and stone, of a total length of 810 feet, and ted on the right bank of the river immediately above the Madison t Bridge; also, in the construction of dams on the left bank of the at Five-Mile Bluff Bar, and a dam to close the secondary channel be- n Twin Islands, at the same bar. The total projected length of dams shore connections at Five-Mile Bluff is 2,600 linear feet, of which feet were built during the past fiscal year. Some work upon a dam ırk Slough was also commenced. The work was performed by day under immediate charge of Assistant A. O. Powell, who carried nstructions faithfully and economically.

herever works have been constructed by the Government for the ovement of the river, the navigation has been benefited, a low-water h of 3 to 4 feet being maintained where, before the works were ırtaken, the depth seldom exceeded 18 inches. The work for im- ement has been principally confined to the extent of river between nouth and Durand, 16½ miles, and to the vicinity of Eau Claire.

e jetties at the mouth of the river have been of incalculable benefit ft and steam-boat navigation in securing a stable channel of suffi- depth where, before improvement commenced, there was a broad ntersected by shallow shifting channels, passable with great diffi- at times of low water by rafts and steamers. A number of shoals een Durand and the mouth of the river still need improvement, some of the dams and revetments are in need of repairs, or rather ll completion.

e injurious effect upon the channels from the arbitrary operation ivate sluicing dams on the river and its tributaries has been no- in preceding reports, Expended during the fiscal year ending June 30, 1887, including outstanding liabilities, $14,127.83.

Total expended from commencement of operations to June 30, 1887, including outstanding liabilities, $111,497.96. This includes work, material, necessary examinations, superintendence and contingencies, and repairs, which for ten years have been considerable on account of the shifting bed of the stream.

Number of linear feet of dams, jetties, and revetments constructed and kept in repair, 1877 (when work was begun) to 1887.

Description.	Locality.	Linear feet.
East jetty, 2,110 linear feet	Mouth of river	6,123
West jetty, 4,013 linear feet	......do	
Shore protection	......do	584
Dam	Little Missouri Chute	300
Dam	Flower-Pot Bar	2,065
Shore protection	Three-Mile Prairie	1,335
Dam	Dark Slough	225
Dam	Wacouta Island	325
Dam	Battle Island	830
Dam	Jack-Staff Island	275
Dam	Plum Island	400
Dam	Dead Lake Cut-off	325
Jetties, including shore-protection connection	Durand	1,290
Dam	Eau Claire	810
Dams	Five-Mile Bluff	1,075
Total		15,782

With the balance from appropriations available July 1, 1887, the work at Five-Mile Bluff Bar and at Dark Slough will be continued, and some necessary work to the existing dams at Wacouta, Battle Island, Dead Lake Cut-off, and Eau Claire, where drives of logs have displaced some of the stone covering, will be executed so far as funds will admit of.

The original estimate, based upon the examination of 1874, included, omitting the Yellow Banks, improvement of about 28 localities, mostly sand and gravel bars, between Eau Claire and the mouth of the river. Many of the unimproved bars vary in size and shift in position, depending upon floods and following stages of water. The banks, easily eroded, also contribute sand to the river after every high water, rendering more or less revetment necessary. Consequently, an estimate of cost made in 1875 would differ from one made in 1883, and both from one made to-day. Insufficiency in appropriations also adds to the ultimate cost, as partly finished work must be maintained.

In 1882 occurred a dangerous diversion of the river into Dead Lake, making a cut-off that threatened destruction of the channel for many miles below it. It was necessary to close this by a strong dam of brush, stone, and piles. Under the appropriation of August 5, 1886, which provided for continuing improvement of the river from the Dalles Dam to its mouth, a dam 810 feet in length was built at Eau Claire. Under appropriations to date, 13 localities have been improved, and the works maintained and repaired. The item of repairs is considerable, as some of the dams were constructed as early as 1877 and 1878.

e following-named localities require improvement:

Locality.	Nature of improvement.	Linear feet.
en the jetties and upper end of Flower-Pot Bar	Shore protection	2,000
	Dam	2,500
re-Mile Bluff Bar	Dams and shore protection	1,600
en Seven-Mile Bluff and Plum Island	Dams	1,800
Ella, between Plum Island and foot of Dead Lake Cut-)am	Dams	800
allé Bars	Dams	1,200
reek Bars	Dams	1,000
Slough	Dams	150
Total		11,050

linear feet, at an average cost of $5 per linear foot	$55,250.00
ontingencies, 10 per cent	5,525.00
	60,775.00
cting balance of appropriation available July 1	5,252.04
The cost of completing the improvement is about	55,522.96

he sum of $25,000 can be profitably expended during the fiscal year ing June 30, 1889, in furtherance of the plan of improvement, and nly between Durand and the mouth of the river.

ince the branch of the Chicago, Milwaukee and Saint Paul Railway built, in 1882, from Wabasha, on the Mississippi River, to Eau ire, the branch being close to, and generally parallel with, the Chippa, the freight and passenger traffic of the latter have declined. The ing of manufactured lumber, lath, shingles, and pickets varies in erent years, the rafts moving down the Chippewa and between the ies into the Mississippi. In 1881, the lumber rafted was reported as ,887,000 feet B. M.; in 1885, 374,138,443 feet; in 1886, 207,205,672 t. The saw-logs, from 300,000,000 to 600,000,000 feet B. M. of which annually run down the Chippewa, are made up into rafts at Beef ugh for points on the Mississippi River.

he total value of the lumber, lath, shingles, pickets, and logs floated the Chippewa River in 1885 is reported as $11,273,350.

he reduction in the cost of running lumber from Eau Claire to the ssissippi River, due to the improvement of the river by the United tes, can be arrived at by comparing the contract rates paid by the niel Shaw Lumber Company. In 1877, the year when the improvent was commenced, they paid 53½ cents per M feet B. M.; in 1886, y contracted for 37 cents.

Attention is invited to the comparative tables of statistics herewith.

his work is in the collection district of Milwaukee, Wis. The collections for the trict of Milwaukee during the year ending December 31, 1886, amounted to 1,221.40.

STRACT OF APPROPRIATIONS MADE FOR IMPROVING CHIPPEWA RIVER, WISCONSIN.

act approved August 14, 1876	$10,000
act approved June 8, 1878	10,000
act approved March 3, 1879	8,000
act approved June 14, 1880	10,000
act approved March 3, 1881	10,000
act passed August 2, 1882	35,000
act approved July 5, 1884	15,000
act approved August 5, 1886	18,750
Total	116,750

Money statement.

July 1, 1886, amount available		$629.87
Amount appropriated by act approved August 5, 1886		18,750.00
		19,379.87
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$12,955.52	
July 1, 1887, outstanding liabilities	1,172.31	
		14,127.83
July 1, 1887, amount available		5,252.04
Amount (estimated) required for completion of existing project		55,522.96
Amount that can be profitably expended in fiscal year ending June 30, 1889		25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Commerce of the Chippewa River, Wisconsin, in 1877, being the year following the first appropriation (August 14, 1876) for work of improvement.

Lumber	feet B. M.	160,000,000
Lath and pickets	number	30,000,000
Shingles	do	40,000,000

The number of steam-boats plying on the Chippewa River in 1877, or the amount of business done by them, can not be stated exactly. It is said, however, that the business was about the same as in 1880, 1881, and 1882. The latter will be found in the comparative statement following.

Present (1886) commerce of the Chippewa River.

Lumber	feet B. M.	207,205,672
Lath	number	77,729,630
Shingles	do	158,645,750
Pickets	do	1,934,340
Logs (Beef Slough)	feet B. M.	465,000,000

But one steam boat plied regularly on the river during the season of 1886. This boat, the *Phil. Scheckel*, ran from the mouth to Dunnville, about half-way between the mouth and Eau Claire.

The boat was run to a [illegible] the Knapp, Stout & Co., company's rafts in floating down the river.

Her passengers and freig [illegible] onfined almost entirely to the company's rafting business. Amount of freight [illegible] s not stated. Number of passengers carried was 4,700.

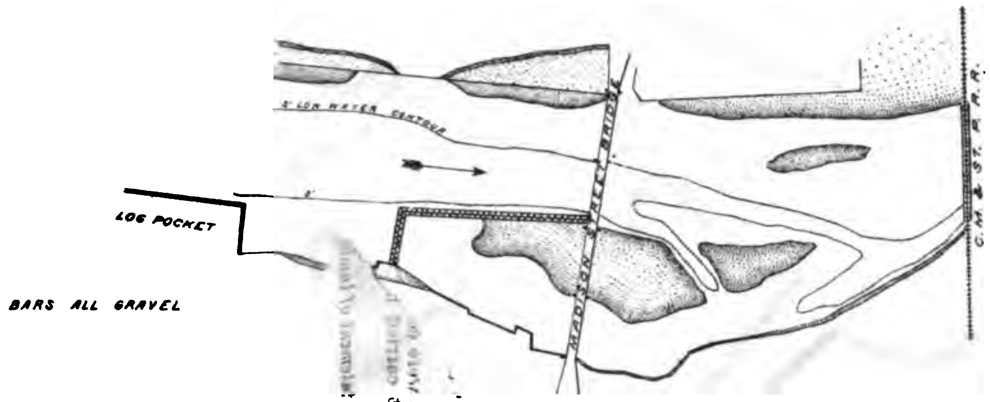
Comparative st [illegible] r, logs, etc., for six years.

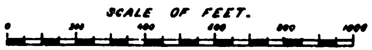
Year.	Lumber.	Lath.	Shingles.	Pickets.	Beef Slough logs.
	Feet B. M.	*Number.*	*Number.*	*Number.*	*Feet B. M.*
1886	207,205,672	77,729,630	158,645,750	1,934,840	465,000,000
1885	374,138,443	95,992,900	195,880,220	75,000,000	600,000,000
1884	298,344,591	88,905,520	160,133,000	1,840,278	534,674,176
1883	269,094,203	82,643,500	129,754,000	1,497,948	450,000,000
1882	375,000,000	66,000,000	150,000,000	2,200,000	350,000,000
1881	342,887,000	64,787,600	121,437,000	1,880,900	300,000,000

Comparative statement of freight and passengers for six years.

Year.	Steam-boats.	Freight carried.	Passengers carried.	Year.	Steam-boats.	Freight carried.	Passengers carried.
	No.	*Pounds.*	*No.*		*No.*	*Pounds.*	*No.*
1886	1	Not stated	4,700	1883	3	3,184,000	4,000
1885	1	690,000	4,728	1882	3	2,640,000	10,000
1884	2	1,500,000	5,500	1881	3	3,932,000	16,[illegible]

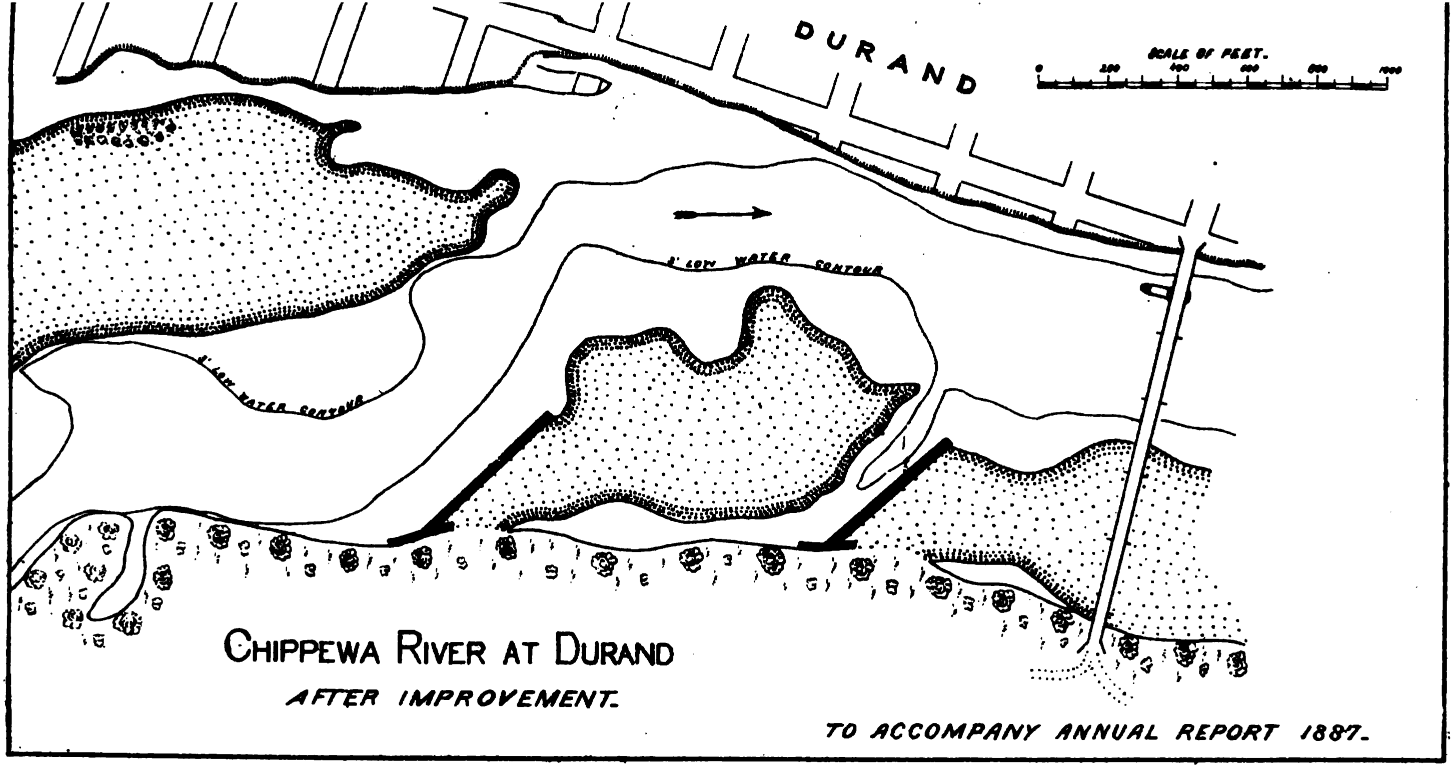
TO ACCOMPANY ANNUAL REPORT 1887





SKETCH
of
CHIPPEWA RIVER AT EAU CLAIRE WIS.
AFTER IMPROVEMENT.

2

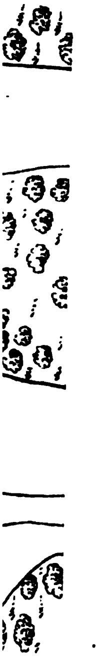


CHIPPEWA RIVER AT DURAND

AFTER IMPROVEMENT.

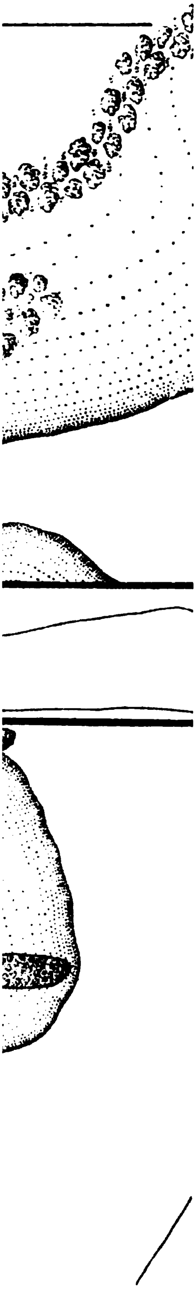
TO ACCOMPANY ANNUAL REPORT 1887.

3



4

5



5

llowing are extracts from a letter of Mr. A. O. Powell, assistant engineer, this , dated Eau Claire, Wis., December 15, 1886:

n 1882 the rates by river from Reed's Landing to Eau Claire were:

-class freight	per 100 pounds..	$0.65
ıd-class freight	do......	.45
l-class freight	do......	.25
·class passenger fare		2.50
ıd-class passenger fare		2.00
;ht on oar stems	each..	.80

.y rail via the Chippewa Valley Division of the Chicago, Milwaukee and Saint Railway, completed in July, 1882:

-class freight	per 100 pounds..	$0.40
ıd-class freight	do......	.34
l-class freight	do......	.29
th-class freight	do......	.24
-class passenger fare (Since October 15, 1886, $1.40)		1.85
ıd-class passenger fare		1.40
;ht on oar stems (approximate)	each..	.40

'he railroad carries the oar stems by weight.

t has not been the practice to insure freight or lumber in transit."

* * * * * * *

'he reduction in cost of running lumber from Eau Claire to the Mississippi River, o United States improvements, can be arrived at by inspecting the contract rates by the Daniel Shaw Lumber Company. In 1877 they paid 53¼ cents per M feet .; in 1886 they contracted for 37 cents.

umbermen claim that they could not have run lumber this year, during the ex- e low water, had it not been for the wing-dams and jetties.

'he improvements have had no effect on freight rates by rail for general merchan-

'he prospective advantages of the completion of the improvement will be con- to the lumbering interests."

A A 6.

ROVEMENT OF CHIPPEWA RIVER AT YELLOW BANKS, WISCONSIN.

ıe object of this work is to prevent erosion of the high sand-banks luffs on the Chippewa River below Eau Claire, and thereby relieve channels of this river and of the Mississippi below the junction of two streams from the masses of sand contributed by those banks.

ıe original estimate of the cost of this work was $64,102.50, as given ıe report upon the cost of improving the Chippewa River, January 1875, and this is the estimate upon which, it is presumed, the ap- ›riation for the work, viz, that of $30,000, by act passed August 2, !, was made.

he project for the work, adopted in February, 1883, is as follows: ows of piles are driven at the foot of the slope at distances of 5 feet :t from centers; between the piles and between the line of piling foot of slope are laid fascines of brush, with sand well incorporated ı them; the finished brush-work is carried to a height of 10 to 12 above low-water mark; on top of the brush saplings are laid par- to the line of piling; across the saplings are ties, two for every 5 length of protection wall, firmly spiked to the piles and to pickets en in rear of the wall, the slopes to be terraced where necessary. It :pected that the sand from the slopes will pack closely against the ıh-work, so as to obviate the necessity of using any large quantity ›ck which, for this work, would be expensive. The top of the brush , however, should be crowned with rock. A few mill-edgings were l at the outset of the work, but they proved as expensive as brush not so effective.

The condition of the work is as follows:

At Waubeek Bank, 2,989 feet long, protection completed.

At Rumsey's Bank, 4,500 feet long, piles all driven and 1,850 linear feet of protection completed.

At Mary Dean Bank, 6,900 feet long, piles have been driven for 625 linear feet, and 139 feet of the protection completed.

The work was all done by day labor.

Two banks near Eau Claire, total length of 8,300 feet, have not as yet had any work done upon them. Total upon which no work has been done, 15,886 linear feet.

The portions of protection wall at Waubeek, Rumsey's and Mary Dean Banks, aggregating 4,969 feet, were completed by the close of 1883. Although they withstood uninjured the unprecedented flood of September, 1884, in the Chippewa Valley, they should receive a crowning of rock.

The completed portions of the work not crowned with stone cost $4.06 per linear foot. It becoming apparent that the original estimate of the cost of the work rendered in 1875 was too low, a revised estimate was presented in Appendix X of the Annual Report for 1833, as follows:

> It is believed that when the present season's work is completed the cost of the protection will average about $4 per linear foot (of wall and terrace), and upon this basis the cost of protecting 24,000 linear feet, the aggregate length of the five banks named above, will be about $96,000. Improvements in the method of work, however, that may be discovered as it proceeds, may reduce the cost below this last figure, but the cost of each bank will vary, depending upon the facility with which material can be obtained. The original estimate was made eight years ago, and contemplated brush and stone revetment. But, leaving out the matter of change in prices of material and labor during the past eight years, there was, at the time the estimate was rendered, no actual experience in the cost of such revetment upon which to base one. The magnitude of the Yellow Banks calls also for a character of work different from ordinary shore protection.

No work of protection was done during the past fiscal year for want of funds. The small balance available at the commencement of the year, $254.84, was held for repairs to the work, and also to pay for storage and care of the engineer property pertaining to the work.

Amount expended to June 30, 1887, including outstanding liabilities	$29,782.00
Amount expended during the fiscal year ending June 30, 1887, including outstanding liabilities	36.84

The sum of $30,000 can be profitably expended during the fiscal year ending June 30, 1889, towards completing the work at Waubeek, Rumsey's, and Mary Dean Banks, including rock crowning. The work at present, being in an unfinished state, is exposed to injury from floods.

This work is in the collection district of Milwaukee, Wis. The collection for this district for the year ending December 31, 1886, amounted to $211,221.40.

Revised estimate of cost of improvement	$96,000
Appropriated by act passed August 2, 1882	30,000
Remaining to be appropriated	66,000
Total amount expended to June 30, 1887, including outstanding liabilities	29,782

For statistics of the trade and commerce to be benefited by this improvement, reference is made to the annual report upon improvement of the Chippewa River, Wisconsin.

Money statement.

July 1, 1886, amount available	$254.84
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	36.84
July 1, 1887, amount available	218.00

mount (estimated) required for completion of existing project........	$66,000.00
mount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00

ubmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

A A 7.

ROVEMENT OF SAINT CROIX RIVER BELOW TAYLOR'S FALLS, MINNESOTA AND WISCONSIN.

he original project for the improvement of this river, adopted in 8, was based upon the results of a survey made in 1874, when the Croix was at a high stage of water and but comparatively few s, etc., to be seen, and contemplated the removal of snags, bowlders, cks, leaning trees, and sand-bars between Taylor's Falls and Prest, and contraction of the low-water channel between Taylor's Falls Stillwater into one of nearly uniform width by means of brush and ne jetties and dams of the same material to close island chutes and ondary channels. Estimated cost, $21,758.

he present project, adopted in 1880 and modified in 1882, is based n the results of a low-water survey made in 1879, the resulting es-ate of cost (see page 1444, Appendix X, Annual Report, 1883) being ,450. This provided for removal of obstructions, as did the original n, excepting that it considered more work for the approaches to the anal" between Four-Mile Island and the foot of the St. Croix Boom n did the original plan.

he first appropriation for the improvement of the St. Croix was ,000, made by act of Congress approved June 18, 1878.

t that date the channel, above Stillwater especially, was incumbered sunken cribs, wrecks, snags, and old boom-piers, and the bends by ning trees. The low-water channel had in many places but little re than 2 feet of depth, and steamers and barges made their way as t they could amongst the obstructions.

nder this appropriation some of the worst obstructions were re-ved between Taylor's Falls and Stillwater.

nother appropriation of $8,000, by act approved March 3, 1879, expended in the same manner, and in addition the stream was roughly surveyed from Taylor's Falls to Prescott, the results of ich were reported January 26, 1880 (see pages 1661–1667, Appendix Annual Report of the Chief of Engineers, 1880).

pon the results and maps of this survey is based the present plan improvement.

he work done in 1878–'79 was as follows.

OBSTRUCTIONS REMOVED.

gs	number..	2,882	Logs	number..	68
mps	do....	1,919	Piles	do....	16
lders	cubic yards..	564	Wrecks	do....	1
ning trees	number...	6,005	Caving bends protected	linear feet	2,200
s or piers	do....	36	Dams built	do....	575

xpended under this project, including expense of survey of 1879, $18,000.

he foregoing work lessened the difficulties to navigation within the its worked over. Under the appropriation of $10,000 by act ap-ved June 14, 1880, work began under the present project. This act vided for the expenditure of $300 " in the improvement of the slough on the east side of said river, known as the canal, between Four-M Island and the foot of the St. Croix Boom."

Some rock and other obstructions were accordingly removed from t channel.

Under the appropriations 1880–1886, the work of improving t channels continued. Above Stillwater the work consisted generally construction of dams, jetties, etc., and removal of obstructions fr the channels. Below Stillwater the work was almost entirely confin to the channels at Hudson and Catfish bars, a few sunken logs hav been removed between Stillwater and Hudson.

The improvement of the Hudson Bar has consisted in dredging in the construction of a long training-wall of piles, timber, brush, stone, in order to cut off troublesome cross-currents setting to the e ward at this point. At Catfish Bar the improvement has consisted dredging and in construction of a training-dam of brush and st from a point above the mouth of Bowles' Creek to a point on the b the object of the dam being twofold:

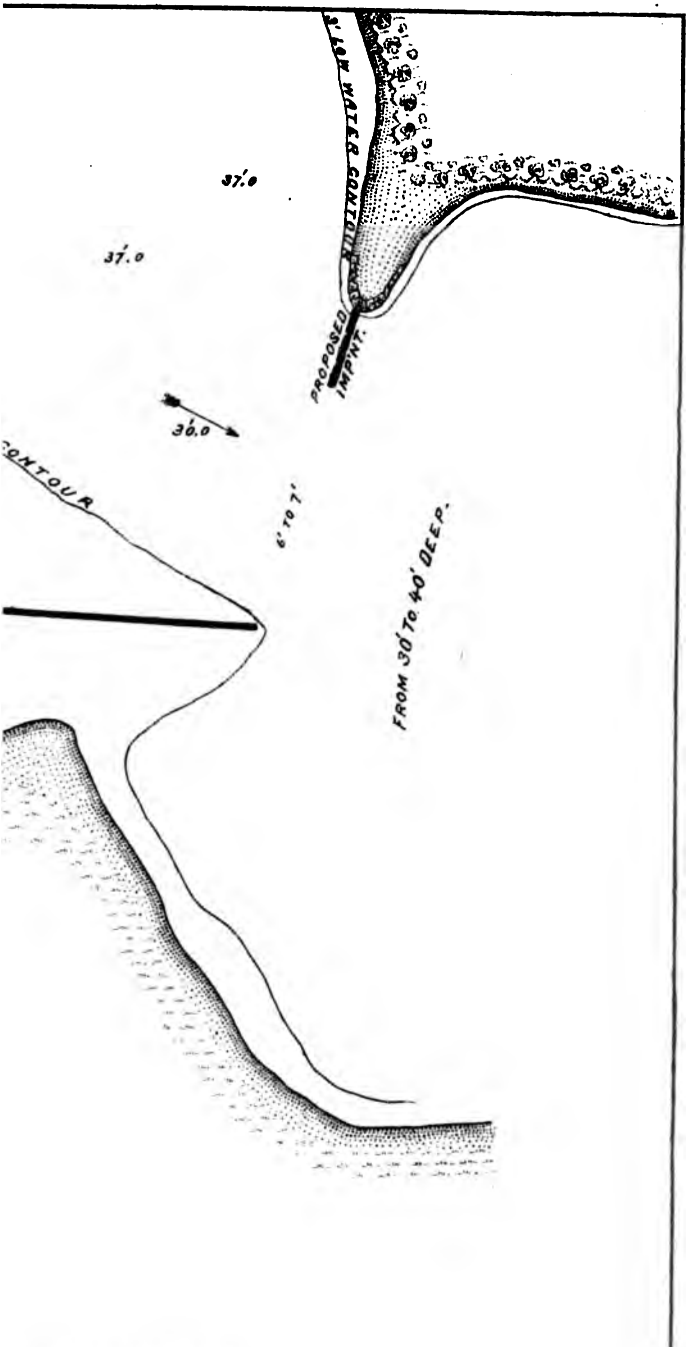
1. To divert the deposits from the creek to the right bank and a from the channel.
2. To confine the low-water volume to the dredged channel.

The channel at Catfish Bar has been kept open by dredging for passage of the largest steamers and rafts since 1882, but dredging regarded as only a temporary measure. The work done during the p fiscal year, and under the appropriation of $7,500 by act of Congress proved August 5, 1886, consisted in dredging the channels at Hud and Catfish bars by means of a scraper-boat operated by a steam and in construction of the dam at Catfish Bar, above referred to; 2, cubic yards of sand and gravel were removed from the Hudson thus rendering the channel at that place available for the passage steamers during the fall of 1886; and 4,000 cubic yards were remo from the channel at Catfish Bar. The construction of the dam at C fish Bar commenced in December, 1886, and was continued until Ma 21, following, the party working on the ice; 1,105 linear feet of d were thus built, but the dam requires more rock and should be lev off and extended 150 feet, and a jetty 250 feet long should be built the Wisconsin side, opposite, to more thoroughly concentrate the l water volume upon the bar. The work of improvement has been local charge of Capt. O. F. Knapp, overseer, who is entitled to m credit for the faithful and economical manner in which he carried instructions.

The improvement already effected at Catfish Bar has been of gr benefit to the navigation of the stream. As many as sixty raft passenger steamers navigate the river at times.

TOTAL OF WORK DONE UNDER PRESENT PROJECT.

Snags removed	number	1,
Leaning trees removed	do	
Stumps removed	do	7
Piles removed	do	
Cribs or piers removed	do	
Wrecks removed	do	
Logs removed	do	1
Clay and gravel removed above Stillwater	cubic yards	1
Bowlders removed	do	
Shore protection and revetment built of brush and stone	linear feet	4,
Dams and jetties built of brush and stone	do	9,
Training-wall at Hudson, built of piles, timber, brush, and stone	do	2,
Dredging at Hudson, approximate	cubic yards	8,
Dredging at Catfish Bar, approximate	do	14,



IMPROVEMENT.

on the east side of
Island and the foot
Some rock and o
channel.
Under the app
channels continue
construction of d
the channels. Be
to the channels at
been removed bet
The improveme
in the constructic
stone, in order to
ward at this poi
dredging and i
from a point ab
the object of th
1. To divert t
from the chann
2. To confine
The channel
passage of the
regarded as onl
fiscal year, and
proved Augus
and Catfish b
and in constr
cubic yards o
thus renderin
steamers duri
from the cha
fish Bar com
21, following
were thus b
off and exte
the Wiscons
water volun
local charg
credit for t
instruction
The imp
benefit to
passenger

Snags remo
Leaning tr
Stumps re
Piles remo
Cribs or p
Wrecks re
Logs rem
Clay and
Bowlders
Shore pr
Dams an
Training
Dredgin
Dredgin

Total amount expended under present project to June 30, 1887, including outstanding liabilities, $64,041.51.

TOTAL OF WORK DONE UNDER ORIGINAL AND PRESENT PROJECT.

Snags removed	number..	3,915
Leaning trees removed	do....	6,219
Stumps removed	do....	2,661
Piles removed	do....	24
Cribs or piers removed	do....	43
Wrecks removed	do....	3
Logs removed	do....	201
Clay and gravel removed above Stillwater	cubic yards..	146
Bowlders removed	do....	633.5
Shore protection and revetment built of brush and stone	linear feet..	6,332
Dams and jetties built of brush and stone	do....	9,173
Training-wall at Hudson, built of piles, timber, brush, and stone	do....	2,465
Dredging at Hudson, approximate	cubic yards..	8,694
Dredging at Catfish Bar, approximate	do....	14,000

Total expended on original and present projects since commencement of work, including outstanding liabilities, $82,041.51.

All of the work has been done by day labor and purchase of materials in open market.

The result of the work to date is a least depth upon the bars above Stillwater, where improvements have been made, of 3 feet at low water and below Stillwater of 4 to 5 feet. Generally, it may be said of the work that at many points navigation has been rendered permanent, where formerly it was uncertain, and that in other places it has been made practicable, where before improvement it was impossible. There are some bars yet that require improvement above Stillwater, and some of the existing works need small repairs. The Hudson Wall should be extended, and the channels at this point and Catfish Bar should receive additional dredging, and the dam at the latter place extended as noted above.

As showing the amount of commerce benefited, and to be benefited by the improvement, reference is made to the accompanying statistics of the St. Croix River.

The largest steamers plying the Mississippi River between Saint Paul and Saint Louis ascend the St. Croix to Stillwater, the head of an immense steam-boat and lumber-rafting business, which is dependent upon these improved channels. Smaller steamers run between Stillwater and Taylor's Falls, carrying passengers, agricultural implements, grain, etc.

Before the completion of the railroad to Taylor's Falls, Minn., the towns along the St. Croix River could get their supplies to and from market only by water and wagon transportation, and even since the completion of the railroad the steam-boats have carried the larger portion of the freight, and for some time to come they will do the same during seasons of navigation, for the reason that they (the steam-boats) can make all the landings along the river, whereas the railroads will strike only certain towns, leaving others along the river to depend upon steam-boats.

The advantages and benefits to the people of the Lower St. Croix Valley due to the improvements already effected are evident from the lowering of freight rates, which, it is stated, have been reduced at least 50 per cent. since the improvement of the stream commenced. On wheat alone the saving in freight is said to have been considerable.

The work of improvement on the St. Croix has also had the effect of lowering the rates of insurance, as well as of causing stronger competition, as it has enabled larger draught boats (Mississippi River packets) to ascend the river and thus compete with those boats that plied exclusively on the St. Croix River, and also with the railroad running to Taylor's Falls.

The sum of $18,950 can be profitably expended during the fiscal year ending June 30, 1889, in furtherance of the existing project, principally at Hudson and Catfish bars, and in repairs to and extension of the revetment at Kelly's Island above Stillwater, where a diversion of the channel has been threatened for several years past.

Portions of the river-bed between Stillwater and Taylor's Falls are much obstructed, at times, by log-booms, which have been noticed in previous reports.

Estimated cost of project as amended	$83,450.00
Amount expended before its adoption	18,000.00
Total amount expended under present project to June 30, 1887, including outstanding liabilities	64,041.51
Total amount expended to June 30, 1887, including outstanding liabilities	82,041.51

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the revenues collected during the year ending December 31, 1886, amounted to $4,591.74; value of domestic exports for 1886, $2,419,847; value of merchandise "in transit" trade, $94,540; duties on same, $52,576.97.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING SAINT CROIX RIVER BELOW TAYLOR'S FALLS, MINNESOTA AND WISCONSIN.

By act approved June 18, 1878	*$10,000.00
By act approved March 3, 1879	*8,000.00
By act approved June 14, 1880	10,000.00
By act approved March 3, 1881	8,000.00
By act passed August 2, 1882	30,000.00
By act approved July 5, 1884	9,000.00
By act approved August 5, 1886	7,500.00
Total	82,500.00

Money statement.

July 1, 1886, amount available	$419.90	
Amount appropriated by act approved August 5, 1886	7,500.00	
		$7,919.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	7,362.95	
July 1, 1887, outstanding liabilities	98.46	
		7,461.41
July 1, 1887, amount available		458.49

Amount (estimated) required for completion of existing project	18,950.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	18,950.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

---

*Appropriated before adoption of present project.

COMMERCIAL STATISTICS.

mparative statement of steamboats and barges, freight, passengers, towing, rafting, logs, lumber, etc., manufactured on the St. Croix River, Wisconsin and Minnesota, for a period of nine years, 1878–1886.

STEAMBOATS AND BARGES.

Year.	In freight and passenger business—		In towing and rafting business—	
	Steam-boats.	Barges.	Steam-boats.	Barges.
878*	3	....	8	....
879	3	....	12	....
880	3	....	29	....
881	2	....	40	....
882	3	24	77	....
883	3	25	51	....
884	3	25	30	....
885	4	33	50	....
886†	6	38	49	....

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time, 1886.

FREIGHT, PASSENGERS, AND LOGS.

Year.	Freight carried, to include merchandise, lumber, wood, etc.	Passengers carried.	Logs towed out of St. Croix River (estimated).	Logs passed through St. Croix Boom.
	Pounds.	*Number.*	*Feet B. M.*	*Feet B. M.*
1878*	82,000,000	15,000	70,000,000	160,000,000
1879	47,786,995	9,244	117,000,000	202,000,000
1880	(‡)	(‡)	200,000,000	207,100,000
1881	*a* 35,000,000	11,015	185,000,000	233,000,000
1882	*b* 60,000,000	10,300	130,000,000	276,000,000
1883	*c* 63,000,000	2,800	108,000,000	270,000,000
1884	*d* 80,000,000	4,000	175,000,000	275,000,000
1885	*e* 85,000,000	10,647	150,000,000	231,000,000
1886†	*f* 180,000,000	12,756	115,700,000	193,500,000

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time, 1886.
‡ Estimated same as 1879.
a About 18,000,000 pounds lumber and wood.
b About 48,000,000 pounds lumber and wood.
c About 53,000,000 pounds lumber and wood.
d About 70,000,000 pounds lumber and wood.
e About 73,000,000 pounds lumber and wood.
f About 85,000,000 pounds lumber and wood.

LUMBER, ETC., MANUFACTURED.

Year.	Lumber.	Shingles.	Laths.	Pickets.
	Feet B. M.	*Number.*	*Number.*	*Number.*
1878*	Not stated....	Not stated....	Not stated....	Not stated.
1879	83,727,820	40,238,000	27,600,000	Do.
1880	132.475,078	54,052,500	37,845,000	Do.
1881	135,000,000	70,000,000	40,000,000	362,000
1882	116,000,000	62,000,000	32,000,000	200,000,000
1883	167,000,000	80,000,000	45,000,000	615,000
1884	125,000,000	25,000,000	25,000,000	615,000
1885	200,000,000	65,000,000	80,000,000	11,000,000
1886†	75,000,000	1,400,000	600,000	Not stated.

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time, 1886.

A A 8.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

For want of funds no work for improvement was done during the past fiscal year.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Major Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The estimates of cost of improvement, based upon results of this examination and survey, are given in the Report of the Chief of Engineers for the year ending June 30, 1867. Two plans were considered, viz, one to improve the navigation of the river from the Yellow Medicine to the mouth of the Minnesota by means of locks and dams, so as to secure 4 feet of water, at a cost of $775,500; and another to secure 2 to 3 feet of water, by removal of snags and bowlders throughout this stretch of river, in addition to the construction of a lock and dam at Little Falls, and the operation of a scraper and dredge-boat, at a cost of $117,000.

The river and harbor act of Congress approved March 2, 1867, appropriated $37,500 for removing snags and bowlders throughout the Minnesota River, thus sanctioning the second plan.

The river and harbor acts of Congress approved June 11, 1870, and March 3, 1871, each appropriated $10,000 for continuing the improvement.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of the Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the Report of the Chief of Engineers for the fiscal year ending June 30, 1873. The removal of obstructions, principally bowlders, was recommended.

The same act (approved June 10, 1872) appropriated $10,000 for the improvement of the stream, which sum was expended in the removal of bowlders, overhanging trees, etc.

By act approved March 3, 1873, there was appropriated—

> For the improvement of the Minnesota River, Minnesota, ten thousand dollars: *Provided*, That one-half of said sum shall be expended between the mouth of the Yellow Medicine and Minnesota Falls, on said river.

This appropriation was applied to the removal of rocky ledges, bowlders, snags, and overhanging trees. The total of appropriations to March 3, 1873, inclusive, was $77,500.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of the Minnesota River." A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles, to determine the practicability of improving the navigation by means of canals, locks, and dams. The results of this survey proved the possibility of lock and dam navigation for the distance passed over, the estimated cost of improvement, as stated in the report of the survey printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1875, being, for five locks and dams and removal of snags, etc., $733,868.63, the cost of removing snags, etc., being therein placed at $34,585.10, including contingencies. Following this report, upon which is based the present project of improvement—at least so far as removal of snags, bowlders, and trees from the channel is concerned—Congress made three appropriations, of $10,000 each, by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

No appropriation by Congress for the improvement of the stream has been made since 1878.

The object of all the work for improvement was to facilitate navigation by steamers. Before any work of improvement was undertaken, the river was almost impassable at low water for boats. The removal of obstructions cleared the way over long stretches of the river between Minnesota Falls and a point about 30 miles below Henderson. Little or no use, however, was made of the improved channels. The rapidly caving banks of that river add their quota of snags and leaning trees to the channel yearly, so that channels which were cleared of obstructions ten years ago are more or less encumbered with them to-day.

It is claimed by those interested in the Minnesota Valley that, were the improvements extended by the construction of locks and dams, steam-boats and barges would navigate the river and carry much of the freight that now depends upon rail for transportation.

Congress, by river and harbor act approved August 5, 1886, authorized a new survey of the Minnesota River with a view to its improvement by locks and dams. This survey, from the mouth to Mankato, is now in progress, and a report upon the same, with estimates and statistics of the valley, will be rendered in time for the consideration of Congress at its next meeting.

Total expended on the original project	$77,500
Expended for survey, 1874	10,000
Expended upon present project, 1875–1879	30,000

As Congress has not appropriated for the improvement of this stream since 1878, it seems proper not to present any estimate in this report for the year ending June 30, 1889.

This work is in the collection district of Minnesota. The nearest port of entry is Duluth, Minn., at which place the total collections from all sources during the year ending December 31, 1886, amounted to $4,591.74. Value of merchandise "in transit" trade, $94,540; duties on same, $52,576.97. Value of domestic exports, $2,419,847.

ABSTRACT OF APPROPRIATIONS MADE FOR THE IMPROVEMENT OF THE MINNESOTA RIVER.

By act approved March 3, 1867	$37,500
By act approved July 11, 1870	10,000
By act approved March 3, 1871	10,000
By act approved June 10, 1872	10,000
By act approved March 3, 1873	10,000
By act approved June 23, 1874	*10,000
By act approved March 3, 1875	10,000
By act approved August 14, 1876	10,000
By act approved June 18, 1878	10,000
Total	117,500

Money statement.

July 1, 1886, amount available	$42.00
July 1, 1887, outstanding liabilities	9.00
July 1, 1887, amount available	33.00
Amount (estimated) required for completion of existing project	703,868.63

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

---

* Used in making survey of river.

A A 9.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

The present, which is also the original, project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877 and amended as to estimate of cost in 1883, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars.

The estimated cost of this improvement, omitting the item of improvement of Goose Rapids, as based upon the reports of 1874, 1875, and 1877 (see pages 730–732, Report of Chief of Engineers, 1878), was $145,310.18, which estimate as revised, and for the reasons stated in Appendix X 8 of the Annual Report of 1883, was increased by $34,000, bringing it up to $179,310.18.

The river and harbor act of Congress approved August 5, 1886, appropriated for this improvement as follows:

> Improving Red River of the North, Minnesota: Continuing improvement from Breckenridge to the northern boundary line of the United States, including dredging, removal of snags and bowlders, and construction of wing-dams, and so forth; and the money heretofore appropriated for locks and dams is hereby made available for this purpose.

This act added to the improvement of the Red River the improvement of Goose Rapids, which had been, up to that time, a separate work.

The balances from appropriations for locks and dams were $46,947.65. (See Annual Report, 1886, Construction of Lock and Dam, Goose Rapids.)

With this appropriation and the small balance from previous appropriations, the work of dredging was resumed, the necessary repairs and additions made to the fleet of dredges and flats, and a new steamer constructed for towing purposes, by utilizing the machinery of a steamer that had been employed upon the Mississippi River reservoirs. The dredging was principally done upon the lower half of Goose Rapids, at points between the rapids and Grand Forks, and on bars below Grand Forks. The excavated material was utilized, as in former years, in forming training-dams to confine and direct the water at low stages, and also to, as far as possible, leave the area of cross-section of the stream after excavation what it was before excavation, and also so placed as to reduce, wherever necessary, the velocity of the stream. In general, the work has been so carried on that, while increasing the depths at crossings, the pools above and below the bars have not been lowered. The material, a tough leathery clay, is not liable to be rapidly washed away, and the best disposition that could be made of it was to use it for dams. To raise the material to the top of the bank through heights of 35 to 45 feet would have been expensive without securing much, if any, advantage, as floods frequently cover the banks and approaches to the river.

The dredges worked over 60.7 miles of river during the fiscal year; 11,505 linear feet of channels were excavated, 13,822 linear feet of dams built, 26 snags and overhanging trees removed from the channels, 27½ cubic yards of bowlders removed, and 71,714 cubic yards of clay excavated.

The cost of the work during the fiscal year averaged 17.06 cents per cubic yard for dredging, including in this the cost of repairs, subsistence, fuel, machinery supplies, tools, rope, castings, etc., much of which was purchased in the spring, and is on hand for use later in the season.

The cost, per cubic yard, by the close of the season, will average about 14 cents, excavated and handled.

The lowest point reached by the dredges was 52 miles, by river, below Grand Forks.

The total work done upon this stream since the first appropriation for its improvement was made by Congress, and distributed over the 280 miles between Fort Abercrombie and the point where dredging ceased this year, below Grand Forks, is as follows:

Dredging	cubic yards	405,893
Total of linear feet excavated		48,230
Total linear feet dams constructed		77,322
Miles of river passed over by dredges		187
Number of cuts made by dredges		122
Number of leaning trees removed		8,900
Number of snags removed		608
Cubic yards of bowlders removed		348⅛
Piles removed		16
Sunken barge removed		1
Average cost per cubic yard of dredging and depositing material, including cost of plant, repairs, etc	cents	29.03
Average cost of same, including first cost of plant only	do	17.65

Cost of dredging, during the time the dredges were actually working, not including cost of plant or of repairs, but including everything else chargeable to the work for that time was from 8.2 to 16 cents per cubic yard. Fair average cost of the same about 11 cents.

Average cost of removing trees and snags, each	$1.49
Average cost of drilling, blasting, and removing bowlders, per cubic yard	4.79

All the work of improvement on this stream has been done by hired labor.

GENERAL CONDITION OF THE WORK.

The 3-foot dredged channels from Moorhead to a point 80 miles north, averaging 60 feet in width at low water, and the 4-foot dredged channels from Grand Forks to a point 52 miles north (distances by river), averaging 70 feet in width, are in good condition, and no difficulty is experienced over those improved portions of the stream by boats loaded for those depths at ordinarily low stage of water, and 3 feet can be carried over the improved portions of the rapids and of the river between Frog Point aad Grand Forks. The removal of snags and trees between Moorhead (opposite Fargo) and Abercrombie improved that portion of the stream for navigation during high and medium stages of water.

The river is subject to land slides, several of which have occurred within the past two years at Goose Rapids and near Frog Point. These slides can never be anticipated, form obstructions when they occur, and have to be removed in whole or in part, thereby increasing the amount and cost of the improvement.

Generally, since the first bars were dredged in 1879, the carrying of grain in barges has been greatly facilitated. Before the dredging commenced in 1879 there was but 1½ feet of water, ruling depth, upon bars between Moorhead and Goose Rapids, and 2 feet on the bars below Grand Forks at ordinarily low water; and before the removal of snags and leaning trees between Moorhead and Abercrombie navigation over this portion of the stream was at all times difficult.

The comparative statement of freight carried during the calendar years 1879–1886, appended, shows considerable fluctuation, being greatest in 1882 and least in 1886. The decrease for 1886 must be attributed mainly to the extremely low water of that year, the stage of water at Grand Forks, during the fall, averaging 1.5 feet lower than had ever before been recorded, and partly to the increased facilities for shipment railroad.

Assistant Engineer R. Davenport reports as follows:

> Owing to the extreme low stage of water, the year ending June 30, 1887, has not been a successful one for steam-boats on the Red River of the North.
>
> After the 1st of July, 1886, no steam boats were run; even in September and October, where formerly there was always a rise, there was not sufficient water to warrant any movement on the river.
>
> This spring there was a rather better stage of water up to about the 15th of June, but, compared with other years, there was not one-fourth the usual supply. Considering the low stage this year, however, the boats, both at Moorhead and Grand Forks, have done unusually well, and report the condition of the river, particularly on the dredged portion, as never better, considering the stage.
>
> The *Grandin* made regular trips from Moorhead north about 75 miles, and the *Pluck* did very well on the river south of Moorhead to McCauleyville. They, however, report that they were compelled to load their wheat barges much lighter than usual at this season of the year to avoid sticking on the bars.
>
> All the boats, excepting the Government boats engaged in the improvement of the river, are now laid up, waiting for a rise. Several hundred thousand bushels of wheat are reported in the elevators along the river awaiting transportation.

GRANDIN LINE.

	Pounds.
Steamer *Grandin*: Merchandise brought up river to Fargo	6,980,580

RED RIVER TRANSPORTATION COMPANY.

Steamer *Pluck*:	
From points south to Moorhead:	
Wheat	4,640,000
From Moorhead to points south:	
Merchandise	30,000
Steamer *H. W. Alsop*:	
From Grand Forks to points north and south:	
Merchandise	92,240
Lumber	685,000
To Grand Forks from points north and south:	
Wheat	7,782,000
Wood	600,000
Total	20,809,820

RECAPITULATION.

	Pounds.
Grandin Line (operating above Goose Rapids)	6,980,580
Red River Transportation Company (operating south of Moorhead)	4,670,000
Red River Transportation Company (operating below Goose Rapids)	9,159,240
	20,809,820

The Red River has been subjected to several consecutive years of drought so that the low-water marks last season receded at points from Moorhead to Grand Forks, and below the latter place, very materially from the previously established low-water marks upon which were based the cost of improvement. Bars and crossings in 1886 were shoal where, during the survey of 1874, sufficient water was reported.

I caused a new estimate to be made of the cost of completing the work, checking the same by an independent calculation. The estimate is as follows:

Breckenridge to Moorhead	$31,663.96
Moorhead to Goose Rapids	18,000.00

Goose Rapids	$25,000.00
Goose Rapids to Grand Forks	4,500.00
Grand Forks to Pembina, including Pelican Bars	22,500.00
	101,663.98
Deducting balance from former appropriations available July 1, 1887	22,065.61
Leaves, as necessary to complete the work	79,598.37

The cost of maintaining the floating property is considerable, and the longer the work is in process of completion the greater will be the cost of such contingencies as repairs and renewals, items that can not be estimated in advance with any degree of exactness.

Although but few steamers, comparatively, navigate the Red River at present, the fact of an improved river being available for an unlimited number of steamers and barges, whenever railroad rates become insupportable, operates to the advantage of the farming community.

Expended during the fiscal year ending June 30, 1887, including outstanding liabilities, $25,732.07.

Expended upon the improvement from commencement of work in 1877 to June 30, 1887, including outstanding liabilities, $147,882.04.

With the balance of funds available, July 1, 1887, it is proposed to continue work below Grand Forks and upon Goose Rapids, and, when the stage of water permits, to remove some shoals at and in the vicinity of Fargo and Moorhead.

Mr. Rufus Davenport, assistant engineer, is deserving of much credit for faithfulness and zeal in carrying out instructions connected with this improvement, and his report of operations and estimate of cost of continuing the work are herewith submitted.

The sum of $40,000 can be profitably expended during the fiscal year ending June 30, 1889, in continuing operations and in removal of obstructions generally between Breckenridge and the northern boundary line, and in care and maintenance of the fleet of dredges, etc.

The Red River of the North from its source to the international boundary line is wholly within the customs district of Minnesota, of which Saint Vincent is the chief port of entry. Collections for year ending December 31, 1886, $7,163; domestic exports for same period, $853,560.

ABSTRACT OF APPROPRIATIONS MADE FOR IMPROVING RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

By act approved August 14, 1876	$10,000.00
By act approved June 18, 1878	30,000.00
By act approved March 3, 1879	25,000.00
By act approved June 14, 1880	20,000.00
By act approved March 3, 1881	18,000.00
By act passed August 2, 1882	10,000.00
By act approved July 5, 1884	10,000.00
By act approved August 5, 1886	46,947.65
Total	169,947.65

Money statement.

July 1, 1886, amount available		$850.03
Amount appropriated by act approved August 5, 1886		46,947.65
		47,797.68
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$21,124.95	
July 1, 1887, outstanding liabilities	4,607.12	
		25,732.07
July 1, 1887, amount available		22,065.61

Amount (estimated) required for completion of existing project........	$79,598.37
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

No. 1.

GRAND FORKS, DAK., *July* 1, 1887.

SIR: The following report on the work of improving the Red River of the North, for the fiscal year ending June 30, 1887, is respectfully submitted:

The order to commence operations was received September 9, 1886. The dredging fleet had been unoccupied for nearly a year, and the machinery of the dredges and all of the boats was badly in need of repair. Owing, however, to the short time that remained for work that fall, the dredges and steamboat were put in working order as soon as possible, only such repairs being made as were absolutely necessary to keep the boats afloat and render the machinery safe to work until the close of the season, when it was proposed to haul out of the water the boats that required important repairs, so that the hulls and machinery could be thoroughly overhauled during the winter and early spring.

The scow derrick and one slide scow were found to be leaking so badly that it was necessary to haul them out at once and leave them on the bank.

The stage of water at the time the dredging was commenced was extremely low, and during the short working season that followed, the stage of water averaged 1.5 feet lower than had up to that time been considered the lowest stage—the low water of 1879.

There was water enough to float the dredges, however, and both worked successfully until the close of the season, November 6.

Dredge No. 1 worked south from Grand Forks, on a section of river that had not been previously dredged; seven bars were cut through, forming a channel of an average width of 60 feet, with a low-water depth of 3 feet; 14,651 cubic yards of material were excavated, which, as usual, were used in forming training-dams; length of training-dams, 4,425 linear feet. Length of river worked over, 5¼ miles. Length of continuous cuttings, 4,200 linear feet.

A number of snags and bowlders were also removed from the channel by the dredge on this section of the river.

Dredge No. 2 worked down river, north, from Grand Forks. This portion of the river had been worked over by the dredges in former years, at a higher stage of water, and many bars that were then passed over to admit of worse obstructions, further down, being removed, were found to be impassable on account of the extreme low water. Two new intermediate cuts were made and two of the old cuttings were partially redredged, and the training-dams repaired and straightened out.

Total excavation by Dredge No. 2, 13,539 cubic yards.

Training-dams formed, 3,000 linear feet.

Length of river worked over, 3¼ miles.

Length of continuous cuttings, 2,900 linear feet.

Steamboat No. 1, *City of Moorhead*, was employed as usual in towing the dredges and in keeping them supplied with fuel, subsistence, etc. Number of trips made by the steamboat, 18; miles traveled, 327.

After the return of the dredging fleet to Grand Forks, at the close of the season, the scow derrick, which had in the mean time been thoroughly recalked, was launched.

Two quarter-boats and one wood barge, that required more complete repairing than could be done in the water, were hauled out on the bank. The remainder of the boats and the dredge and steamboat machinery were put in order, and the work closed for the winter.

Owing to extreme low water this season, after the 30th of June, all the steamboats except the Government steamboat were laid up, as there was not water enough to float them, except on those portions of the river that had this season been worked over by the dredges.

SEASON OF 1887, TO JUNE 30.

The work of overhauling and repairing the dredging fleet and machinery was commenced February 22.

The four boats hauled out the previous fall were found to require considerable repairs to their hulls, as well as complete recalking and painting.

The machinery of the dredges and steamboat, particularly in the case of Dredge No. 2, also required extensive repairs; worn-out castings, steam-pipes, etc., had to be taken out and replaced and an almost complete new set of valves and fittings was found to be necessary. A new boom was required for Dredge No. 2, and the boiler of Dredge No. 1 was in such condition as to require considerable work to render it efficient and safe. Considerable repairs were also required on the hulls and decks of the dredges and the entire outfit required repainting.

This work was carried on through the remainder of February, March, and a portion of April; and by the time the river was clear of ice the dredging fleet was ready to commence operations.

In addition to the boats then on hand, as instructed, a new wood barge, 60 feet long, 16 feet beam, and 4 feet depth of hold, was built, and another, 50 feet long, 18 feet beam, and 4 feet deep, purchased. These barges were required, in addition to those on hand, to keep the dredging fleet supplied with fuel.

The cost of the repairs to the dredges, quarter-boats, etc., and the construction of the new wood-barge, and of the barge purchased, was as follows:

Dredge No. 1	$448.87
Dredge No. 2	926.41
Quarter-boat No. 1	367.55
Quarter-boat No. 2	162.75
Construction of new wood barge	688.95
Repairs of barges	534.58
Repairs of steam-boat No. 1	382.81
New wood barge purchased, and repairs	142.82
A total cost for repairs, purchase of barge, etc., of	3,654.74

In the latter part of February, while the work just mentioned was being carried on, instructions were received to commence the construction of a new steamboat, to be worked in connection with the dredging fleet, the machinery of the steamer *Kate*, formerly employed on the Upper Mississippi River in connection with the work on the reservoirs, having been ordered shipped to Grand Forks for that purpose.

Active operations on the construction of this boat were not commenced until the 19th of March, there having been considerable delay in getting the oak lumber for the hull. From that date, however, the work was pushed as rapidly as possible, and the hull was launched on the 25th of May. The boat was completed and ready for work on the 24th of June, at a total cost of $5,687.06. With the machinery, the boat would, probably, be valued at $8,000.

The following is a general description of the boat: Length of hull, 96 feet 6 inches; length over all, 112 feet 6 inches; breadth of beam, amidship, at deck, 22 feet 3 inches; at knuckle, 21 feet 9 inches; depth of hold, amidship, 4 feet; rise, forward 1 foot 6 inches, aft 1 foot 3 inches; diameter of wheel, 11 feet 6 inches; number of buckets, 13; length of buckets, 14 feet; length of boiler, 16 feet; diameter of boiler, 42 inches; return-flue pattern, 10 flues, 5¼ inches in diameter; engines, piston-valve, link motion; diameter of cylinders, 8¼ inches; length of stroke, 44 inches; draught when loaded ready for work, with about 12 cords of wood, 16 inches.

On the main-deck are quarters for 8 men, with cook-room, store-room, oil-room, etc. On the boiler-deck there is a small "texas," 10 feet wide and 33 feet 4 inches long, containing 4 double state-rooms, an office, and dining-room.

The pilot-house is on top of the "texas," in front; the dimensions are 8 feet by 8 feet, and 8 feet high.

Height from the water-line to the top of the smoke-stacks, 35 feet 9 inches.

The boat is supplied with a "tow-post" for towing astern, as is now usual on the Red River boats, and a steam capstan run, by two 4 by 6 cylinders.

DREDGING OPERATIONS IN 1887 (TO JUNE 30).

Both dredges commenced work in the latter part of April, dredge No. 1 moving south to Goose Rapids, dredge No. 2 north to the point at which work was discontinued last season.

The work on the rapids consisted mainly in shutting off side channels back of the islands, and in forming training-dams and wing-dams to reduce the velocity of the current and narrow the channel, as well as occasional channel-cuts, when absolutely necessary.

The dredge excavated 22,220 cubic yards. With the material excavated, 3,407 linear feet of training and wing-dams were constructed. Length of river worked over, 14.7 miles; length of channel-cuts, 2,305 linear feet.

The dredge is now at work on the rapids, 51.2 miles, by water, south of Grand Forks.

The work north of Grand Forks consisted in repairing the training-dams, and in redredging, to a limited extent, a few of the cuts made in former years; also, in making new channels through the bars north of the former end of the work.

The total excavation at this end of the river was 21,300 cubic yards. With the material excavated, 2,990 linear feet of training-dams were formed. Length of channel-cuts, 2,100 linear feet. Length of river worked over by the dredge, 37 miles; of this distance, however, 32 miles had been partially dredged before and only 5 miles was on new river.

Dredge No. 2 is now at work 52 miles north of Grand Forks.

Steamboat No. 1 (*City of Moorhead*) and steamboat No. 2 (since completion) have been employed in towing the dredges and wood barges, and in keeping the dredging fleet supplied with fuel and subsistence.

Steamboat No. 1 made 37 trips. Distance traveled, 2,012 miles.

Steamboat No. 2 made 2 trips. Distance traveled, 184 miles.

The low water of this season, though not quite as bad as last year, has nevertheless interfered considerably with the work, reducing the amount of dredging, and consequently increasing the cost. The average stage in May and June was less than 0.5 foot above the low water of 1879.

Summary of work done during the fiscal year ending June 30, 1887.

	Cubic yards excavated.	Wing and training dams.	Length of channel-cuts.	Bowlders removed.	Snags and overhanging trees.
		Linear feet.	*Linear feet.*	*Cubic yards.*	
Dredge No. 1, 14 channel-cuts and 10 training and wing dams.	36,875	7,832	6,505	27½	22 trees, 4 to 20 inches; 3 snags, 12 to 20 inches; 1 snag, 16 inches.
Dredge No. 2, 7 cuts and 8 training and wing dams.	34,839	5,990	5,000		
Total	71,714	13,822	11,505	27½	26 T. & S.

Number of working days, dredge No. 1	93
Number of working days, dredge No. 2	81
Total days	174

Average daily digging, 412+ cubic yards.

Length of river worked over by dredge No. 1, 20.2 miles.

Length of river worked over by dredge No. 2, 40¼ miles.

(Only 5 miles of new river.)

The cost of the work done during the year averaged 17.06 cents per cubic yard. (Allowing, however, for fuel, subsistence, machinery supplies, tools, rope, castings, etc., purchased this spring, considerable of which is on hand for use later in the season, the cost will average about 14 cents per cubic yard excavated.)

Cost of subsistence, per ration, 42.6 cents.

The total work done upon this stream since the first appropriation was made and distributed over the 280 miles between Fort Abercrombie and the point reached June 30, 1887, is as follows:

Dredging ... cubic yards	405,893
Total linear feet excavated	48,210
Total linear feet of dams constructed	77,322
Miles of river passed over by dredges (32 miles worked over in 1887)	157.7
Number of cuts made by dredges	123
Number of leaning trees removed	8,900
Number of snags removed	608
Cubic yards of bowlders removed	348¼
Piles removed	16
Sunken barge removed	1

The outlook for the remainder of the dredging season is faitly favorable. The water is still very low, only 0.5 foot above the low-water stage of 1879. The rains have been more frequent than up to this time last year, and the quantity of water that has fallen has been greater; but, as the sources of supply, the lakes at the headwaters of the Otter Tail and Red Lake rivers, have been drained down to the very lowest point, and the entire valley parched almost to dryness, the river has received but little benefit as yet, though the prospects of better water are fair.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

No. 2.

GRAND FORKS, DAK., *June* 30, 1887.

SIR: As instructed, I have the honor to submit the following report on an estimate of the cost necessary to complete the work of improvement on the Red River of the North from Breckenridge to the boundary line, and also from Breckenridge north toward Fergus Falls.

Leaving out of consideration the work already done and forming an estimate of the cost of the improvement from the condition of the river as it now is, the following is respectfully submitted:

From Breckenridge to Moorhead, if the plan proposed in the original estimate is adopted, I believe the original estimate, $22,663.98, will be sufficient to cover the cost of the work; but as there was an evident error in the low-water mark selected, Mr. Schmidt reports the discharge at Moorhead, "in round numbers, at 1,000 cubic feet per second," and it has since been found to frequently fall below 500 cubic feet per second, and last season probably did not exceed 250 cubic feet per second for two months, I believe it will be necessary to add to the estimated cost of improving that section of the river the cost of one season's work for a dredge, $9,000, making the estimated cost of the improvement between Moorhead and Breckenridge, $31,663.98. (In estimating the cost of a season's work for a dredge at $9,000, the cost of the necessary steamboat service is included.)

This sum will, I believe, cover the cost of all the work of improvement that can be done on that section of the river, other than by locks and dams, though, naturally, no improvement can be made that will render it navigable at a stage of water as low as was reached during the months of August and September, 1886, when the discharge was reduced to about 250 cubic feet per second.

Between Moorhead and the head of Goose Rapids there remain about 10 miles that have not been worked over by the dredges (the first 10 miles above the rapids). This portion of the river, it is estimated, will require the work of a dredge for at least one full season, at an estimated cost of $9,000. And on the portion of the river worked over by the dredge up to 1882, the remainder of the river between Moorhead and the head of the rapids, it is estimated that at least one full season's work will be required to remove the bars that were passed over, and the obstructions in the shape of landslides, etc., that have come in since, new bars that have formed, etc., and in repairing the old cuts and training-dams, making the estimate of the cost of completing the improvement between Moorhead and the head of Goose Rapids, $18,000.

The improvement of Goose Rapids, if the present plan proves successful (dredging and the construction of clay wing and training dams), can be done by two season's work of one of the dredges, at an estimated cost of $18,000; if, however, the clay dams do not prove sufficiently permanent, and brush dams are required, $5,000 in addition to the cost of dredging will be required, making the total estimate for the improvement of Goose Rapids, $25,000. As far as the work has progressed on Goose Rapids this season, it can be reported that only clay of the most impermeable quality has as yet been found, of the very best for the work required; even the gravel-bars were found to have only a thin layer of gravel on top, the remainder being clear blue clay.

With Goose Rapids, as with the river above Moorhead, the river can be made navigable at the cost mentioned, when there is an ordinary low-water discharge from 500 cubic feet to 700 cubic feet per second; when, however, the water falls to any considerable quantity less than 500 cubic feet per second, no improvement other than locks and dams will render it navigable.

From the foot of Goose Rapids to Grand Forks, by water 35 miles, but little remains to be done; probably two months' work at an estimated cost of $3,000 would do all the work that can be done in removing the few bars that remain on that section of the river, all of the worst bars, 7 in number, in the vicinity of Grand Forks, having been removed in 1886.

North of Grand Forks there remain about 40 miles to be worked over, down to and including the Pelican Bars, 92 miles below Grand Forks. On this section of the river, the remaining 40 miles, the services of a dredge will be required for at least two seasons (a season's work is estimated at 6 months) at an estimated cost of $18,000, and on the river already worked over, to 52 miles north of Grand Forks, the services of a dredge will be required for about three months, at an estimated cost of $4,500, in making new cuts and training-dams and in repairing the work of former years, making the estimated cost of the work north of Grand Forks (in these estimates it is considered that no work will be required between Pelican Bars and Pembina) $22,500.

In connection with the estimate of the cost of improvement of the river north of Breckenridge, the following on the Otter Tail River between Breckenridge and Fergus Falls is respectfully submitted.

The Otter Tail River has never been surveyed, but the following information was obtained last season during a hasty examination.

For the first 20 miles below Fergus Falls the river is full of bowlders, and small rapids are frequent. The slope is considerable, and no improvement other than by locks and dams is considered practicable. The remainder of the river to Breckenridge is narrow and crooked, but there is sufficient water, at ordinary stages, to float a medium-sized steamboat.

It is believed that a dredge, working one season, at an estimated cost of $9,000, would do all that can be done in the way of widening out some of the crooked bends and in dredging the channel when necessary.

The average width of the Otter Tail is reported to be about 80 feet. In earlier years steamboats sometimes loaded with merchandise, etc., at the point above mentioned (about 20 miles below Fergus Falls), for Pembina and other places on the Red River, and a large fleet of flatboats yearly left that locality, loaded with flour, lumber, coal, merchandise, etc., to be floated down the Red River to points in Manitoba.

RECAPITULATION.

Estimated cost of improvement:	
Breckenridge to Moorhead	$31,663.98
Moorhead to Goose Rapids	18,000.00
Goose Rapids	25,000.00
Goose Rapids to Grand Forks	4,500.00
Grand Forks to Pembina, including Pelican Bars	22,500.00
Total	101,663.98

If it is proposed to attempt the improvement of the Otter Tail the estimate would be increased to $110,663.98.

This estimate largely exceeds the original estimate, but the conditions have so changed in the last few years that a complete revision of the estimate of the cost of the work required to complete the improvement is absolutely necessary.

Up to 1886 there was every reason to suppose that the low-water discharge at Moorhead would never fall below 500 cubic feet per second (Schmidt in 1874 estimated the low-water discharge on the upper river at 1,000 cubic feet per second, and states that he bases his opinion, as to the low-water stage, "on information obtained that covers the last 20 years"), and that the river at and below Grand Forks would fully average 1,000 cubic feet per second at the lowest stage. Experience of the last two years has, however, proved that the supposition as to the low-water stage was entirely erroneous, though up to that time, the spring of 1886, no lower stage than the low water of 1879 had been known.

The lowering of the low-water stage naturally increases the estimated quantity of work to be done on portions of the river not yet dredged, and necessitates dredging in many localities formerly passed over by the dredge on what was supposed to be "good river."

In addition to the increased work required by the reduced discharge, a number of extensive land-slides have come into the river during the last two years, which also render it necessary to do more work than was formerly contemplated.

The banks of the Red River are always moving on the bend side, discharging large quantities of clay and earth into the river, but during the last two years the slides have been more extensive and more numerous than ever before noticed, at least since the work of improvement was commenced. Two years ago, in 1885, a slide occurred 5 miles north of Moorhead which must have brought into the river at least 100,000 cubic yards of clay and earth. And last spring, 1886, on the rapids, a slide containing probably 200,000 cubic yards, completely filled the river, forming for a time a sharp fall of 5 feet or more. The river in a few months formed a narrow and crooked channel through the obstruction, but when the dredge passed over that portion of the river this spring it was found necessary to excavate 3,000 cubic yards of material from the channel at that point to permit the passage of steamboats (the river at that place was formerly 200 feet wide), and for 10 miles below the slide it was found that new bars had been formed, which will all have to be dredged, in what was formerly considered fairly good river.

In addition to the extensive slides above mentioned, numerous smaller slides have also occurred, both on the improved and unimproved portions of the river. In some localities below Grand Forks they have entirely changed the shape of the bottom of the river. Two new cuts made this spring, No. 9 A and No. 9 B, requiring the excavation of 5,200 cubic yards, were rendered necessary from this cause alone, and a number of other places have been found where digging must soon be done from the same cause.

As previously mentioned, the banks of the Red River are always in motion, to an extent, though why the slides should have been more numerous during the past two years is not known. The fact that they have been, and the necessity of increased dredging on account of them, is, however, self-evident.

Very respectfully, your obedient servant,

R. Davenport,
Assistant Engineer.

Maj. Chas. J. Allen,
Corps of Engineers, U. S. A.

COMPARATIVE STATEMENT OF FREIGHT MOVED BY STEAM-BOATS ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA, FOR EIGHT YEARS, 1879 TO 1886.

1879	pounds	35,718,731
1880	do	43,301,515
1881	do	53,114,861
1882	do	63,303,629
1883	do	50,627,951
1884	do	58,091,472
1885	do	46,085,499
1886	do	21,013,657

[Note.—As before stated, the great falling off in amount of freight moved in 1886 was due to the unprecedentedly low water of that year, the river, at Grand Forks, registering 1 foot and 6 inches lower than ever before recorded.]

A A 10.

CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

This proposed improvement was reported upon, with estimate of cost, December, 1877. The object of the work was to overcome the fall at the worst obstruction, near the head of the rapids, so as to connect with the proposed dredging improvement of the river above and below the rapids. Estimate (1877) of cost, $219,287.99. Congress, by act approved March 3, 1881, appropriated the sum of $20,000 towards the work, and, by act passed August 2, 1882, made another appropriation for it of $30,000.

The total amount appropriated was considered too small in proportion to the probable cost of the work to warrant commencing operations. In addition, cost of materials and labor had changed since the date of the first estimate, and more detailed information in regard to the rapids was required than had theretofore been obtained.

It was deemed advisable to make a thorough and detailed survey of the entire extent of the rapids, with a view to submitting to Congress a close estimate of the cost of improvement. A survey was made during the season of 1883, and a report thereon, with maps, submitted January

21, 1884. This report presented the cost of three plans for improving the rapids, as follows:

(1) Locks and dams at Buffalo Neck and Isabella Island	$476,378.49
Dredging	4,750.00
Total	481,128.49
(2) Lock and dam at Buffalo Neck	261,378.49
Dredging	12,750.00
Total	274,128.49
(3) Dredging the bars on the rapids and utilizing the dredged material for dams, training-walls, etc	30,000.00

A lock and dam at the rapids were first suggested in the report of March 4, 1874, at which date there had been no experience in dredging the obstructions and utilizing the material, such as was gained subsequently in dredging the river above and below the rapids, 1879–1882.

The report of January 21, 1884, suggested for consideration the advisability of rendering the appropriations already made for a lock and dam available for dredging, and the river and harbor act of Congress, approved August 5, 1886, authorized such expenditure in the following words:

> Improving Red River of the North, Minnesota: Continuing improvement from Breckenridge to the northern boundary line of the United States, including dredging, removal of snags and bowlders, and construction of wing-dams, and so forth: and the money heretofore appropriated for locks and dams is hereby made available for this purpose.

The balance from the appropriations for lock and dam was accordingly transferred to the improvement of the Red River of the North, so that there are no operations to report for the year ending June 30, 1887, under the head of "Construction of lock and dam at Goose Rapids."

Amount expended (in examinations) to June 30, 1887, is $3,052.35, which also is the total amount expended.

No appropriation is asked for the year ending June 30, 1889.

The Red River of the North and its tributaries, from their sources to the international boundary line, are wholly within the customs district of Minnesota, of which Saint Vincent is the chief port of entry. The collections at the port of Saint Vincent and sub-ports on the international boundary line for the calendar year ending December 31, 1886, $7,163; domestic exports, $853,560.

For commercial statistics of the Red River, see annual report for improvement of the Red River of the North, Minnesota and Dakota.

ABSTRACT OF APPROPRIATIONS MADE FOR CONSTRUCTION OF LOCK AND DAM AT GOOSE RAPIDS ON THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

By act March 3, 1881	$20,000
By act August 2, 1882	30,000
	50,000

Money statement.

July 1, 1886, amount available	$46,947.65
July 1, 1887, amount available	(*)

---

[*] The river and harbor act approved August 5, 1886, transferred the balance of appropriations for locks and dams to the general improvement of the Red River.

A A 11.

PRELIMINARY EXAMINATION OF HARBOR AT HUDSON, LAKE SAINT CROIX, WISCONSIN.

ENGINEER OFFICE, U. S. ARMY,
Saint Paul, Minn., December 6, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination of the harbor at Hudson, Lake St. Croix, Wisconsin, made in pursuance of sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

Hudson is on the east bank of the lake, and distant about 20 miles from the mouth of the river of which the lake is an enlargement in width. The harbor was surveyed in 1879. The St. Croix River from the mouth of Taylor's Falls, a distance of 57 miles, has been under improvement in consequence of appropriations by Congress for that purpose made in 1878 and subsequent years.

Following is an extract from the report of Assistant Engineer F. T. Hampton, who visited Hudson on the 1st instant for the purpose of obtaining statistical and other information bearing upon the public value of the harbor:

> As there are no commercial organizations of any kind in Hudson, my only means of ascertaining anything was by interviewing those citizens who had been in business for a number of years.
>
> * * * * * * *
>
> Before the day of railroads the river was the natural outlet to the trade of this section. Hudson then shipped all its grain by river. * * * But this river trade has all passed away. Only occasionally does a boat touch at Hudson. During the past navigation season there were about two boat arrivals per week, usually the *Cleon*, plying between Saint Paul and Stillwater, which would handle at this point a small amount of freight.
>
> * * * * * * *
>
> I have not been able to learn the amount of freight handled, but I judge from the opinions I heard expressed that it would not exceed 150 tons.
>
> The country around Hudson is very fertile and thickly settled by a prosperous people. Wheat is the great staple; about 1,200,000 bushels are shipped by rail from Hudson annually. The population of the town is 3,500; few manufactures. There are three flour-mills in and near the town, total capacity 400 barrels per day; one saw-mill, capacity 8,000,000 feet, B M. annually. I endeavored to learn the tonnage in and out by rail, but this information could not be furnished by the local railroad agent.
>
> The public feeling appears to be that the Government, in improving the channel on the right side of the river, in the general interests of navigation, deprived Hudson of any advantage there might be in having the main channel to pass in front of the town, and that now something should be done to repair this injury by improving the channel in front of the town. This forms the basis of Hudson's demand.
>
> It is my opinion that if the commerce existed any steam-boat which could get up to Saint Paul could easily get to Hudson in the present low-water condition of the river. The boat might not be able to reach the depot landing at Walnut street, but could get sufficiently near not to be inconvenient for business. Boats drawing 4 feet can, on a low stage, get up to Commercial street, within two blocks of the depot (this is the lower depot).
>
> * * * * * * *
>
> Hudson has superior natural advantages for good steam-boat landings a few blocks below the depot. There is ample depth of water at all times; a few short docks are all that is needed. I think it of questionable utility for the Government to spend money in opening a channel up to Walnut street, which appears to be the desire of the citizens. I think, however, a survey might be made to ascertain the necessity—if any—of building a dike somewhere above Walnut street, say near foot of Vine, to arrest the encroachment of the sand-bar on the channel in front of the town. I do not know that this encroachment is taking place, but it appears to me that this would be the only useful object of the survey. It might also determine whether the construction of the United States dam threatens (as some citizens of Hudson maintain it does) to shoal up the channel in front of the town by destroying the current, formerly due to the Brickyard Channel.

It is difficult to predict, in the absence of definite or extended information, the prospective value to commerce of an improvement at Hudson by extending deep water to a point opposite the lower railroad depot. The cost of a dike to divert the deposits from Willow River from the channel along the Hudson Front, and the rate of increase in shoaling in front of the city, could only be determined by a survey.

The shoaling is almost entirely due to a railroad embankment which juts out into the lake from a point just above the mouth of the Willow River and extends to within 1,250 feet of the west bank; from the end of this embankment to the west bank are several railroad-bridge spans, all of which, the draw-spans and one long span excepted, are closed to ordinary low-water discharge by masses of riprap and débris. The effect of the embankment and obstructed spans is to deprive the city front of the scouring action, more or less, that might otherwise be expected when the St. Croix is at a fair stage.

The training dam, parallel to the west bank and distant about half a mile from Hudson, constructed by the United States for the general improvement of the river, has no bearing upon the shoaling along the city front.

In view of the facts stated, I am of opinion that no improvement at present is needed for the harbor at Hudson.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

A A 12.

PRELIMINARY EXAMINATION OF RED LAKE RIVER FROM GRAND FORKS TO RED LAKE, MINNESOTA.

ENGINEER OFFICE UNITED STATES ARMY,
Saint Paul, Minn., December 1, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination of Red Lake River from Grand Forks to Red Lake, Minnesota, made in accordance with the requirements of sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

The Red Lake River discharges into the Red River of the North opposite the city of Grand Forks, Dak. From the lake to the mouth of the river the distance, by water is about 325 miles. The river, which is very tortuous, may be divided into three sections, viz, from Red Lake to the mouth of Thief River, 125 miles; from Thief River to Fisher's Landing, 160 miles; and from the latter point to the mouth of the river, 40 miles.

From Red Lake to Thief River the stream is sluggish, with a general width of 200 feet and depth of 2 feet at low water; flows through a generally open prairie, and is bordered more or less by marshes. This section of the river is all within the limits of the Red Lake Indian Reservation, and has only been navigated by flat-boats and bateaux, though it is reported that a small steam-boat is under construction at Saint Hilaire, in expectation of settlement of the region. With the exception of occasional bowlders in the bed of the stream, no obstructions to a 2-foot navigation exist between Red Lake and the mouth of Thief River.

From Thief River to Fisher's Landing the bed of the stream is encumbered by immense quantities of bowlders and occasional small rapids. The average width is 250 feet. On this section of the river are two dams for utilization of water-power: one at Red Lake Falls, with a head 15 feet; the other at Crookston, head 10 feet.

From Fisher's Landing to the junction of the river with the Red River of the North the current is sluggish, the width of the stream averaging 150 feet and depth, at low water, 2½ feet. The landing was at one time the terminus of the Saint Paul and Pacific Railroad (now the Saint Paul, Minneapolis and Manitoba Railway), and supplied large quantities of freight and passengers to steamers plying between it and points on the Red River. Since the extension of the railroads the steam-boats have been withdrawn from the Red Lake River, which is now spanned near its mouth by an iron highway bridge, thus practically closing the river to Red River boats.

STATISTICS.

Assistant Engineer R. Davenport, who went over the greater part of the ground in November, reports under this head as follows:

> With the exception of the area included in the Indian reservation, the country adjacent to Red Lake River is already extensively cultivated, and the productive area is steadily increasing.
>
> The area of Polk County, through the center of which the river runs, is stated to be 1,995,054 acres, of which about 200,000 are cultivated; and wild hay is cut from about 30,000 acres.
>
> The wheat crop of the county in 1886 is estimated at 2,500,000 bushels; oats, 1,200,000 bushels; and other crops in proportion.
>
> There are five villages on the river between Thief River and the outlet: St. Hilaire, population, 300; Red Lake Falls, population, 1,000; Crookston, population 4,500; Fisher's Landing, population 300; and East Grand Forks, population 300. The population of the county is estimated at 25,000.
>
> The city of Grand Forks, Dak., population 7,500, is situated on the Red River, opposite the outlet of Red Lake River.
>
> The manufactures, principally flour and lumber, are distributed as follows:
>
> Saint Hilaire, two saw-mills, daily capacity 50,000 feet, B. M. and one flour mill, daily capacity 100 barrels, in course of construction.
>
> Red Lake Falls, two saw-mills, daily capacity 50,000 feet, B. M., two flour-mills, daily capacity 175 barrels.
>
> Crookston, one saw-mill, yearly capacity 20,000,000 feet, B. M.; two flour-mills, 250 barrels daily capacity.
>
> At Grand Forks there are two flour-mills, with a daily capacity of 150 barrels, and two saw-mills of 250,000 feet, B. M., daily capacity. There are from one to five elevators in each town on the line of the railroads, for storing and handling wheat, etc. At Grand Forks there is a transfer elevator for unloading wheat barges.
>
> About 40,000,000 feet B. M. of pine logs are cut each year on the waters tributary to Red Lake River.
>
> All transportation, both by rail and water, in this section is at present controlled by the St. Paul, Minneapolis and Manitoba Railroad Company. They own the only line of steamboats and barges now operating on the Lower Red River.
>
> A new railroad line, said to be a branch of the Northern Pacific Railroad, is now in course of construction to Red Lake Falls, and will shortly be extended to the Red River at Grand Forks.
>
> The lumber interest is destined, at a date probably not very remote, to be of great importance in this section, and though there is no pine timber on Red Lake River, it is the only water outlet to a section of country estimated to contain from 10,000,000,000 feet B. M. to 20,000,000,000 feet B. M. of standing pine.
>
> Lumbering operations have, so far, been confined to the headwaters of Clear Water River, one of the principal tributaries of Red Lake River, and to some of the small streams emptying into Red Lake.
>
> The country in the vicinity of Red Lake is, however, covered by immense pine forests, which will be available as soon as the lands now held by the Indians are placed in the market.
>
> With reference to the possible improvement of Red Lake River, from the information obtained during this examination, as briefly set forth in this report, it would ap-

pear that the river from Red Lake to Thief River, a distance of 125 miles, is fairly navigable without much, if any, improvement.

From Thief River to Fisher's Landing, a distance of about 160 miles, the river can only be made navigable by the construction of a series of locks and dams, an expensive improvement that the requirements of commerce can hardly be claimed to demand, as yet, at any rate.

From Fisher's Landing to the outlet, 40 miles, but little improvement would be necessary, other than the removal of snags, overhanging trees, and possibly a little dredging.

Of Red Lake Assistant Davenport reports:

> The construction of a reservoir dam at Red Lake, and the equalization of the discharge, would be of material benefit to such portions of Red Lake River as are navigable, without the construction of locks and dams, and would be of incalculable benefit to the Red River of the North in connection with the present project of improvement, by increasing the volume of water during the low-water period, and in reducing the spring floods, which are often very disastrous in the Red River Valley.

It appears that while the Red Lake River is susceptible of improvement for navigation by light-draught steamers, the cost of such would be out of all proportion to the present requirements of its valley, or to any public benefit to be derived from an improvement. Red Lake could probably be converted into a reservoir, and, could it be controlled in the interests of navigation, would probably form a valuable adjunct to the improvement of the Red River of the North from Grand Forks to the Northern boundary line. A complete survey of Red Lake and River with a view to creating a reservoir, would cost about $30,000.

As to the Red Lake River, I am of opinion that it should not at present be classed among the streams worthy of improvement by the General Government.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

A A 13.

PRELIMINARY EXAMINATION ON THE CAUSES OF THE EXTRAORDINARY OVERFLOWS OF THE CHIPPEWA RIVER, WISCONSIN, AND WHAT MEANS, IF ANY, CAN BE ADOPTED TO PREVENT THEIR RECURRENCE.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., December 7, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination on "the causes of the extraordinary overflows of the Chippewa River, Wisconsin, and what means, if any, can be adopted to prevent their recurrence," made as required by sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

In accordance with detailed instructions from myself, Assistant Engineer Archibald Johnson visited the points on the Chippewa River between the mouth of the Flambeau River and the confluence of the Chippewa and Mississippi where he would be most likely to obtain authentic accounts of the noted floods of the valley and, in particular, of that of 1884, the highest recorded, and which brought wide-spread destruction.

Assistant Johnson, in his report dated December 1, gives particulars, more or less minute, of the floods of 1838, '47, '55, '57, '58, '66, '80, and '84.

The last-named caused the river at Chippewa Falls, about 14 miles above Eau Claire, to rise to a height of 26 feet above low-water mark, and at Eau Claire, 57 miles above the mouth of the river, to a height of 27 feet above the same mark. The maximum quantity of flood-water flowing into the Chippewa River just below the confluence of the Eau Claire River and the Chippewa was about 130,000 cubic feet per second. Large areas of the valley were overflowed, railroad and highway bridges destroyed, railroad track torn up, and farms injured, the total damage estimated at $2,000,000.

Of this flood Mr. Johnson writes:

This flood was mainly caused by an extraordinary rainfall over a small area of the water-shed, but all information points strongly to the fact that the crowning wave was due to the destruction of the embankment approaches of the Little Falls Dam and the Paint Creek Dam, and perhaps to some extent by the destruction of the lower dam on the north fork of the Eau Claire River, which occured on the 10th of September. The rain did not extend above the mouth of the Flambeau River on the Chippewa, but was confined to the water-shed of Deer Tail Creek, Jump River, Fisher River, Yellow River, Paint Creek, Eau Claire River, Bob's Creek, Duncan's Creek, Red Cedar River, O'Neill's Creek, and the small brooks between these. No reliable data could be obtained as to the amount of rainfall, but it is said to have varied from 10 to 19 inches in thirty-six hours. According to the United States Signal Service's tornado chart of September 9, a tornado commenced in northwestern Iowa and southeastern Dakota at 5 p. m., local time, and extended in a northeasterly direction striking White Bear Lake and Marine Mills, Minn., Clear Lake, Clayton, and New Richmond, Wis., and lost its force in the forests of Wisconsin. It is more than probable that the extraordinary rainfall was from the storm-clouds of this tornado. Jump River rose 32 feet, Fisher River 20 feet, and all the other tributaries below the mouth of the Jump were swollen higher than ever before known. On the night of the 9th the dam at Bloomer went out, tearing away every bridge on the river, five in number, including several valuable buildings in Chippewa Falls. Shutnecht's Dam, on Duncan's Creek, also went out during the flood on this stream. The embankment approaches of the Little Falls Dam went out about 4 p. m. on the 10th, and those of the Paint Creek Dam about 12 o'clock on the night of the 10th. The Paint Creek and Little Falls dams were repaired after the flood of 1880, and the Paint Creek Dam was raised 4 feet, making it a 14½-foot dam. It has a weir 360 feet long. It has five gates, each 20 feet wide and 20 feet high, resting on a floor 5 feet above the bed of the stream. Its shore connections were embankments of sand and gravel, the one on the north side being about 400 feet long. When the Little Falls Dam was repaired after the flood of 1880 there was no change made in its height or water-way. Its height was 22 feet and its water-way 267 feet, as already stated.

Now the maximum flood at Eau Claire occurred at 11 a. m., or nineteen hours after the Little Falls Dam went out. It is claimed by the owners (the Chippewa Logging Company) of the Little Falls Dam that the gates were opened before the pond was full. The Chippewa Lumber and Boom Company (the owners of the Paint Creek Dam) claim that their gates were open. Be this as it may, the flood passed over the Little Falls Dam. There was a large amount of logs held by booms above this dam, and when the booms gave way the logs and water held back passed over the dam and cut away the embankment approaches, besides cutting heavily into the banks of the river, until a channel was formed around the crib-work of the dam. A wave came down, passing over the embankment of the dam at Paint Creek, and cutting away the approaches and earth down to the bed-rock formed a new channel for the river on the west side of this dam. Since the flood of 1884 the Little Falls Dam has been repaired and remodeled leaving a much greater water-way than it formerly had. The Paint Creek Dam has not yet been repaired.

The capacity of the Paint Creek Reservoir in 1884 was probably about 200,000,000 cubic feet, and that of the Little Falls Reservoir about 700,000,000 cubic feet. These figures are only approximate, but in any event it is well known that when the Little Falls Dam is full, and logs are being sluiced through it, the water raises the river at Eau Claire at the Dells Dam about 4½ feet, and reaches there in about nineteen hours. Whenever the Paint Creek Dam was operated in connection with it, the water would be raised about 6 feet. In passing the Eau Claire Dells Improvement Company's Dam this is confined to a rollway or weir of about 413 feet.

During the flood, however, the water-way over the Dell's Dam was about 650 feet wide. In that case the depth would be about 4 feet. The Little Falls Dam being 22 feet high above the bed of the river, and the floor of the sluices being on a bed or platform 5 feet above the bed of the river, the area of water-way when the dam was full would be 4,539 square feet. When the dam is full the average width of

> the river is about 600 feet, which, multiplied by the depth, 22 feet, would give 13,200 square feet of a cross-section. The water-way is therefore about 34 per cent. of the cross-section. The average width of the river at Paint Creek Dam for a stage of 14 feet above the bed of the river is about 510 feet. Its cross-section is therefore 7,140 square feet. The area of its gateway below the crest of the rolling dam is about 900 square feet, or about 12½ per cent. of the cross-section. These dams therefore formed obstructions in the river, and as the shore connections were constructed simply of earth the embankments would wash out rapidly, and I think it is safe to say that the effect of these two dams raised the water at the Dell's Dam at Eau Claire at least 3 feet. This wave would be reduced in depth below Eau Claire according to the width overflowed and the slope of the river. At Meridean it would be about 12 inches, and at Durand about 15 inches. A good many small dams on the small tributaries went out at different times during this flood, but their capacities are usually very small, and they can be emptied in from three to seventy hours, while furnishing a 3-foot stage on their streams.

The Little Falls Dam and the Paint Creek Dam are respectively 44 and 18 miles above Eau Claire.

With reference to the value, in restraining floods, of the proposed reservoirs on the Chippewa River and its tributaries (full reports in regard to which are in the Annual Report of the Chief of Engineers for 1880), whose united capacity was estimated at 25,000,000,000 cubic feet, round numbers, it appears that while they could probably hold 11 per cent. of the mean annual discharge of the Chippewa River, they could not, even if they had been created prior to the flood of 1884, have exerted any influence in restraining that flood, as their basins were entirely out of the range of the rainfall which produced it; a rainfall which occurred when the Chippewa and its tributaries were at a low stage of water.

The locations of the proposed reservoirs (Paint Creek excepted) are on tributaries above the mouth of the Flambeau. The streams mentioned above as pouring their floods into the Chippewa in 1884 all discharged into that stream at points below the Flambeau. As to the proposed Paint Creek Reservoir, its capacity—about 500,000,000 cubic feet—would be insignificant in comparison with the 10,000,000,000 cubic feet which probably flowed over and through the dam at that locality during the worst period of the flood.

The flood of 1884 has been especially noticed, because it was the greatest ever recorded in the Chippewa Valley.

If this flood had resulted from a rainfall uniformly distributed over the valley, the proportion of water that the proposed reservoirs could have retained would have reduced the flood somewhat in the valley immediately below them, but their general effect would have been too small to have been appreciable.

Assistant Engineer Johnson forcibly presents the situation in the following words:

> If the reservoir dams above referred to were constructed for the purpose of restraining floods, it would be necessary to keep them open until it became apparent that a flood was forming; and when the flood below was over, the reservoirs would have to be emptied in order to have them ready for another flood. This would be detrimental to the large lumbering interest over the 1,570 square miles of the water-shed of these proposed reservoirs, as well as along the river as far as the Little Falls Dam.
>
> Lumbering is now being done on all or nearly all the streams of the water-shed of these reservoirs, and quite a number of sluicing dams exist. To carry on the lumbering interests these dams are necessary, and if the water-shed is controlled by dams for restraining floods, these interests would be ruined. On the other hand, the damage by floods to commerce is very trifling, as it is never more than two or three days that navigation is interrupted by floods, and then there are railway facilities.
>
> Now that the people of the valley have a high-water mark that they can rely on, railways, bridges, and valuable buildings will be built so that they can not be destroyed by a flood similar to that of 1884. As for the farming lands in the valley, they must be flooded with every flood. There is no sure remedy. Aside from the holding ground of the reservoirs above described, there is no other of any importance. The water-

shed of the Chippewa Valley has such a slope that the streams above Eau Claire are very rapid, and are usually confined to narrow valleys which are only adequate for the discharges that are liable to occur at any time. The holding of water by the dams on the small tributaries has very little to do with the restraining of floods, and when they go out their damage is usually of a local nature, and do not appreciably affect the floods.

On the main river, and on the large streams such as the Eau Claire, Yellow River, etc., while their capacity is not sufficient to appreciably restrain a flood, their volumes, when suddenly released by the failure of the dams, appreciably affect the rise with a wave. The owners of these dams for lumbering and other purposes have always pursued a shortsighted policy of building cheap structures, always lacking in their shore connections the elements of stability. However, whenever damage is due to the failure of these structures, the owners are responsible for the amount of it.

As I am unable to see that the extraordinary floods of the Chippewa River can be prevented, I make no estimate of the cost of any survey.

In conclusion, I am of opinion that the floods of the Chippewa River can not be controlled to a sufficient extent to warrant the General Government in undertaking to control them, and that no further examination or survey in this direction is necessary.

The report of Assistant Engineer Johnson contains so many facts of value that I forward it herewith entire, notwithstanding that I have quoted largely from it.

Very respectfully, your obedient servant,

Chas. J. Allen,
Major of Engineers.

Brig. Gen. James C. Duane,
Chief of Engineers, U. S. A.

REPORT OF MR. ARCHIBALD JOHNSON, ASSISTANT ENGINEER.

Saint Paul, Minn., *December* 1, 1886.

Sir: I have the honor to make the following report of a preliminary examination made by me, as instructed in your letter of November 13, 1886, as to the causes of the extraordinary overflows of the Chippewa River, and of the means that can be adopted as far as possible to prevent their recurrence:

Owing to the small amount available for this examination all that could be done was to visit the valley of the Chippewa, and obtain information of the floods from records and from individuals living in the valley.

On the 19th November I proceeded to the valley of the Chippewa, and visited various points from the Little Falls Dam, which is situated on the Chippewa River 32 miles by land from Chippewa Falls, to the mouth of the river.

The extraordinary overflows of the Chippewa River, as far as I have been able to learn, occurred during the years 1838, 1847, 1855, 1857, 1858, 1866, 1880, and 1884.

Of the flood of 1838 Mr. T. E. Randall, who has written a history of the Chippewa Valley, says: "Messrs. Allen and Brunette concur in the statement that the winter of 1837-'38 and the spring of 1838 were very remarkable for extremes of cold and heat, of drought and flood." * * * "Spring came early, the month of March being cloudless and warm as June, but the most fearful storms of winds, hail, rain, thunder, and lightning prevailed in April, May, and June, the temperature varying in twenty-four hours from zero to 70 on some occasions, and causing the highest water in the Chippewa ever known."

* * * * * * *

This was written in 1875 at Eau Claire, Wis., his place of residence.

"From Eau Claire to the Mississippi the bottom-lands from bluff to bluff were covered from 10 to 15 feet deep." * * * "The Mississippi was also high, flooding Wabasha's Prairie where Winona now stands, with water 10 feet deep.

This is all the information obtainable of the flood of 1838.

The same writer says of the flood of 1847: "The winter of 1846-'47 was in some respects very remarkable. Scarcely any snow fell, and so intensely cold was the weather, that the water in the Chippewa at the falls froze to the bottom, forcing it to overflow in the same manner we frequently see small rivulets rise to the surface and cause a fresh layer of ice every night, and this continued until every rock, island, and tree on the falls were submerged with ice, lying solid in many places 20 feet in thickness from the bottom." "But if the winter was remarkable for want of snow, the spring was still more remarkable for absence of rain, there being scarcely enough to lay the dust through the entire months of April and May." * * * "But on the evening of the 5th of June, after a foggy morning and a hot, windy day, rain commenced falling, accompanied with the most fearful thunder and lightning I ever before heard or witnessed, and continued to pour down in torrents until 8 o'clock the next morning, at which time the Chippewa had risen 12 feet, and was covered with logs, drift-wood, and the débris of piers and booms from the falls, where a total wreck of all the costly structures placed in the river during the previous winter to stop and hold logs had been made; nothing was left but the mill, and its race and guard-locks were completely demolished or filled with gravel. More than 10,000 logs, the entire stock out of Yellow River, were carried away, and the total avails of a winter's operations perished in this flood."

Mr. Randall does not say how much more than 12 feet the river rose, but says that "all the way from the foot of the dalles (present site of the Chicago and Northwestern Railroad Bridge) to the Kelsey Street Bridge, the water poured over the west bank of the river into the depression beyond in sufficient depth to float the largest logs."

The flood of 1855 is described by the author as follows:

"But little rain had fallen from early April until the 6th July, when a dark cloud formed directly over the territory drained by the Chippewa, clearly visible from this place (Eau Claire) and the falls. No rain fell here, and only a little hail at the falls, but dark masses of clouds could be seen rolling and gathering from every direction into that one spot in the heavens, accompanied with fearful peals of thunder that made the earth tremble, and this continued for thirty hours, appearing every moment as though it were coming right down upon us, but actually spending all its force in that locality.

"The consequence was a sudden and terribly destructive rise in the river, bringing down vast quantities of logs and drift-wood, which drove with such force against those piers that the channel was soon cleared of all obstructions, and more than 70,000 logs (25,000,000 feet), together with their piers and booms, were carried away and scattered all over the bottoms and amongst the sloughs of the Lower Chippewa."

The flood of 1857 was due to heavy rains, and commenced on the first of May. Mr. M. D. Prindle, of Durand, says that the river was out of its banks for sixty-two days, but no damage of any consequence was done.

The flood of 1858 was caused by an ice freshet, according to Mr. Randall, which is something that rarely happens on the Chippewa. It had such power that everything in the river was swept before it, such as piers, booms, and a vast amount of logs.

Of the flood of 1866 Mr. Randall says:

"In April, 1866, occurred one of those destructive ice-freshets, bringing down jams of ice, logs, and drift-wood in such force as to carry away booms, piers, and all other obstructions that interfered with the swollen, uncontrollable flood. The entire Chippewa bottom was overflowed and covered with logs and drift-wood. There was no Beef Slough Boom then, and the delta of the river, and even many islands in the Mississippi, were filled with logs."

The flood of 1880 commenced at Eau Claire on the 11th of June, and reached its maximum about 12 o'clock on the night of the 13th. At Chippewa Falls it reached its maximum about 12 m. on the 13th, and began falling at the rate of about an inch an hour. At Chippewa Falls the rise was 23 feet above low water. At Eau Claire, at the Kelsey Street Bridge, just below the mouth of the Eau Claire River, the extreme rise was 23 feet. At the Eau Claire Dells Improvement Company's Dam the head was 13 feet 6 inches on the crest of the rolling-dam, while the water passed over all the piers of the lock and dam. The discharge over this dam at the maximum stage was about 77,000 cubic feet per second, and the Eau Claire River contributed about 20,000 cubic feet per second. At Durand the rise was 14 feet above low water.

This extraordinary rise in the river was mainly due to heavy rains, which were general on its water-shed. At the same time heavy rains prevailed on the water-sheds of the Wisconsin, St. Croix, and Mississippi rivers.

Quite a number of dams went out, but their destruction occurred a sufficient length of time in advance of the maximum stage for their waters to have passed, and evidently did not add much, if any, to the extreme stage. On the 11th June, at 6 o'clock, the two dams at Bloomer, situated on Duncan's Creek, and 14 miles from Chippewa Falls, went out, carrying with them three bridges, two large barns, and a cooper-shop. Two other dams on Duncan's Creek, one at Chippewa Falls, and one 4 miles above, went out, doing considerable damage to buildings on that stream in the city. On the morning of the 12th the embankment approaches of the Paint Creek Dam, which was situated on the Chippewa River just below the mouth of Paint Creek, and 4 miles above Chippewa Falls, were washed out, liberating its contents of water and about 90,000,000 feet of logs. It was a 10½-foot dam, and its flowage line was confined within the banks of the river. Its capacity could not have been more than 100,000,000 cubic feet. (For description of this dam see Annual Report of the

Chief of Engineers, United States Army, Part II, 1880, Appendix U, pages 1631 and 1632.) The Little Falls Dam on the Chippewa also went out by its shore connections being destroyed. The floor of the sluices of this dam was 5 feet above the bed of the river and had a width of water-way of 267 feet, or about one-half the width of the river. (See page 1631 of the Annual Report of the Chief of Engineers, United States Army, Part II, 1880, Appendix U.) On the morning of the 12th about 150,000,000 feet of logs, which were jammed in above Chippewa Falls, broke away, and were held in the Eau Claire Dells Improvement Company's pond at Eau Claire until 1 a. m. on the 13th, when the booms there broke, allowing about 200,000,000 feet of logs to pass over the crest of the dam and down the valley of the Chippewa to its mouth. Both highway bridges at Chippewa Falls were swept away on the morning of the 13th; at the same time the dam on the main river broke at the shore connection. A good many dams on the small tributaries went out, doing considerable damage on these streams. The Kelsey Street Bridge at Eau Claire went out on the 13th. The river was out of its banks over quite an area in Chippewa Falls, Eau Claire, Porterville, Meridean, and Durand, and caused much damage to residences and places of business. At Eau Claire portions of the town were 8 or 10 feet under water. From Eau Claire to the mouth of the river the valley was usually flooded from bluff to bluff, and a large amount of crops ruined. The damage caused by this flood has been estimated from $1,000,000 to $1,500,000.

The flood of 1884 was the highest of which there is any record. At Eau Claire the river began to rise in the afternoon of the 9th of September from a stage of 1 or 2 feet above low water, and at 11 a. m. on the 11th it was 27 feet above low water at the Kelsey Street Bridge, just below the mouth of the Eau Claire River. It remained at that stage about one hour and fell nearly as rapidly as it rose. By 2 p. m. on the 14th it had fallen 13 feet. After this it fell rapidly until an ordinary stage was reached. At Chippewa Falls the maximum stage was 26 feet above low water, and 3 feet higher than the flood of 1880. At Durand, where the valley is about a mile wide between the bluffs, the rise was 15 feet 8 inches above low water, and 20 inches higher than the flood of 1880. The maximum stage occurred at Durand about 11 p.m. on the night of the 11th.

On the crest of the Eau Claire Dells Improvement Company's Dam at Eau Claire, the head of water at the maximum stage was 17 feet 2 inches, or 3 feet 8 inches higher than the flood of June, 1880. The discharge over this dam at the maximum stage was about 108,000 cubic feet per second. At the upper dam of the Eau Claire Lumber Company at Eau Claire, there was a head of 11 feet, giving a discharge of about 22,000 cubic feet per second. The discharge at the mouth of the Eau Claire River in the Chippewa was therefore about 130,000 cubic feet per second.

This flood was mainly caused by an extraordinary rainfall over a small area of the water-shed; but all information points strongly to the fact that the crowning wave was due to the destruction of the embankment approaches of the Little Falls Dam and the Paint Creek Dam, and perhaps to some extent by the destruction of the lower dam on the north fork of the Eau Claire River, which occurred on the 10th of September. The rain did not extend above the mouth of the Flambeau River, on the Chippewa, but was confined to the water-shed of Deer Tail Creek, Jump River, Fisher River, Yellow River, Paint Creek, Eau Claire River, Bob's Creek, Duncan's Creek, Red Cedar River, O'Neill's Creek, and the small brooks between these. No reliable data could be obtained as to the amount of rainfall, but it is said to have varied from 10 to 19 inches in thirty-six hours. According to the United States Signal Service's tornado chart of September 9, a tornado commenced in northwestern Iowa and southeastern Dakota at 5 p. m. (local time), and extended in a northeasterly direction, striking White Bear Lake and Marine Mills, Minn., Clear Lake, Clayton, and New Richmond, Wis., and lost its force in the forests of Wisconsin. It is more than probable that the extraordinary rainfall was from the storm clouds of the tornado. Jump River rose 32 feet, Fisher River 20 feet, and all the other tributaries below the mouth of the Jump were swollen higher than ever before known. On the night of the 9th the dam at Bloomer went out, tearing away every bridge on the river—five in number—including several valuable buildings in Chippewa Falls. Shutnecht's Dam, on Duncan's Creek, also went out during the flood on this stream. The embankment approaches of the Little Falls Dam went out about 4 p. m. on the 10th, and those of the Paint Creek Dam about 12 o'clock on the night of the 10th. The Paint Creek and Little Falls dams were repaired after the flood of 1880, and the Paint Creek Dam was raised 4 feet, making it a 14½-foot dam. It has a weir 360 feet long. It has five gates, each 20 feet wide and 20 feet high, resting on a floor 5 feet above the bed of the stream. Its shore connections were embankments of sand and gravel, the one on the north side being about 400 feet long. When the Little Falls Dam was repaired after the flood of 1880, there was no change made in its height or water-way. Its height was 22 feet and its water-way 267 feet, as already stated.

Now the maximum flood at Eau Claire occurred at 11 a. m., or 19 hours after the Little Falls Dam went out. It is claimed by the owners (the Chippewa Logging

Company) of the Little Falls Dam that the gates were opened before the pond was full. The Chippewa Lumber and Boom Company, the owners of the Paint Creek Dam, claim that their gates were open. Be this as it may, the flood passed *over* the Little Falls Dam. There was a large amount of logs held by booms above this dam, and when the booms gave way the logs and water held back passed over the dam and cut away the embankment approaches, besides cutting heavily into the banks of the river, until a channel was formed around the crib-work of the dam.

A wave came down passing over the embankment of the dam at Paint Creek, and, cutting away the approaches and earth down to the bed-rock, formed a new channel for the river on the west side of this dam. Since the flood of 1884 the Little Falls Dam has been repaired and remodeled, leaving a much greater water-way than it formerly had. The Paint Creek Dam has not yet been repaired. The capacity of the Paint Creek Reservoir in 1884 was probably about 200,000,000 cubic feet, and that of the Little Falls Reservoir about 700,000,000 cubic feet. These figures are only approximate, but in any event it is well known that when the Little Falls Dam is full and logs are being sluiced through it the water raises the river at Eau Claire at the Dells Dam about 4½ feet, and reaches there in about *nineteen hours.* Whenever the Paint Creek Dam was operated in connection with it the water would be raised about 6 feet. In passing the Eau Claire Dells Improvement Company's dam this is confined to a roll-way or weir of about 413 feet. During the flood, however, the water-way over the Dells Dam was about 650 feet wide. In that case the depth would be about 4 feet. The Little Falls Dam being 22 feet high above the bed of the river, and the floor of the sluices being on a bed or platform 5 feet above the bed of the river, the area of water-way when the dam was full would be 4,539 square feet. When the dam is full the average width of the river is about 600 feet, which, multiplied by the depth—22 feet—would give 13,200 square feet of a cross-section. The water-way is therefore about 34 per cent. of the cross-section.

The average width of the river at Paint Creek Dam for a stage of 14 feet above the bed of the river is about 510 feet. Its cross-section is therefore 7,140 square feet. The area of its gateway below the crest of the rolling dam is about 900 square feet, or about 12½ per cent. of the cross-section. These dams, therefore, formed obstructions in the river, and as the shore connections were constructed simply of earth the embankments would wash out rapidly; and I think it is safe to say that the effect of these two dams raised the water at the Dells Dam at Eau Claire at least 3 feet. This wave would be reduced in depth below Eau Claire according to the width overflowed and the slope of the river. At Meridean it would be about 12 inches, and at Durand about 15 inches. A good many small dams on the small tributaries went out at different times during this flood, but their capacities are usually very small and they can be emptied in from three to seventy hours, while furnishing a 3-foot stage on their streams.

The damage caused by this flood was far greater than that of any previous flood. The damage to lumbermen was not as great in regard to logs as that of 1880, as the logs that broke away from booms above Eau Claire were held at the Eau Claire Dells Improvement Company's pond. At Chippewa Falls all the highway bridges across the Chippewa River and three railway bridges were carried out. At Eau Claire four railway bridges and four highway bridges were carried down-stream as well as buildings. About 40 miles of the track of the Chicago, Milwaukee and Saint Paul Railway, between Eau Claire and the mouth of the river, were washed out. At Chippewa Falls, Eau Claire, Meridean, Porterville, and Durand a great many buildings were inundated to a depth of 10 or 12 feet. The loss to the valley has been estimated at about $2,000,000. The farming lands in the valley were mostly damaged by the deposit of sand, in some places to a depth of as much as 12 inches.

The recurrence of the floods of the Chippewa River can only be prevented in a slight degree under ordinary conditions. There is a condition, however, under which a flood could be controlled; but the probability of the condition ever existing is exceedingly remote. If the eleven proposed reservoir dams at the headwaters of the Chippewa River be constructed and controlled exclusively for the restraining of floods there will be a remedy proportional to the conditions of the rainfall. The mean annual rainfall of Wisconsin is about 30 inches according to the best information we have; and according to gaugings made on the Mississippi at Crow Wing, Min., about one-third of the rainfall finds its way into the streams. The conditions are the same, excepting that in Wisconsin the streams are much more rapid, owing to the water-shed having a greater slope. Hence the factor one-third may be safely used. The water-shed of the Chippewa River is about 9,600 square miles. Thirty inches of rainfall would be 669,081,600,000 cubic feet. One-third of this, or the mean annual discharge of the Chippewa, would be 223,027,200,000 cubic feet. The capacity of the eleven proposed reservoir dams, Bear Lake, Little Chief Lake, Moose Lake, Pa-kwa-wang, Courtes Oreilles, Butternut Lake, Rest Lake, Bear Creek, Round Lake, Square Lake, and Park Lake, is 24,734,290,805 cubic feet. (See Table I, Appendix I, page 1648, Annual Report of the Chief of Engineers, U. S. Army, Part 2, 1880.)

I have omitted the Paint Creek Reservoir owing to its insignificance as compared to its water-shed. Now, if the rainfall should be uniform over the water-shed, the reservoirs would control about 11 per cent. of a 30-inch rainfall, a greater percentage for a less and a less percentage for a greater rainfall. From calculations made of the discharge of the Chippewa at the Dells Dam at Eau Claire of the flood of 1884, there must have been a total discharge of about 19,000,000,000,000 cubic feet. If the flood had been due to a uniform rain, the per centage of water that might have been held back would have been too small to be appreciable. The flood of 1884 occured from heavy rains where there is no holding ground; and the reservoir system would not have restrained it in the least. If, however, the rain should be confined to the water-shed of the eleven proposed reservoirs, then the flood might be checked; but this is a very remote probability, and may never occur.

If the reservoir dams above referred to were constructed for the purpose of restraining floods, it would be necessary to keep them open until it became apparent that a flood was forming; and when the flood below was over the reservoirs would have to be emptied in order to have them ready for another flood. This would be detrimental to the large lumbering interest, over the 1,570 square miles of the water-shed of these proposed reservoirs, as well as along the river as far as the Little Falls Dam. Lumbering is now being done on all or nearly all the streams of the water-shed of these reservoirs, and quite a number of sluicing dams exist. To carry on the lumbering interests these dams are necessary, and if the water-shed is controlled by dams for restraining floods, these interests would be ruined. On the other hand, the damage by floods to commerce is very trifling, as it is never more than two or three days that navigation is interrupted by floods, and then there are railway facilities.

Now that the people of the valley have a high-water mark that they can rely on, railways, bridges, and valuable buildings will be built so that they can not be destroyed by a flood similar to that of 1884. As for the farming lands in the valley, they must be flooded with every flood. There is no sure remedy. Aside from the holding ground of the reservoirs above described, there is no other of any importance. The water-shed of the Chippewa Valley has such a slope that the streams above Eau Claire are very rapid, and are usually confined to narrow valleys, which are only adequate for the discharges that are liable to occur at any time. The holding of water by the dams on the small tributaries has very little to do with the restraining of floods, and when they go out their damage is usually of a local nature, and do not appreciably affect the floods. On the main river and on the large streams, such as the Eau Claire, Yellow River, etc., while their capacity is not sufficient to appreciably restrain a flood, their volumes when suddenly released by the failure of the dams appreciably affect the rise with a wave. The owners of these dams, for lumbering and other purposes, have always pursued a short-sighted policy of building cheap structures, always lacking in their shore connections the elements of stability. However, whenever damage is due to the failure of these structures the owners are responsible for the amount of it.

As I am unable to see that the extraordinary floods of the Chippewa River can be prevented, I make no estimate of the cost of any survey.

Respectfully, your obedient servant,

ARCHIBALD JOHNSON,
Assistant Engineer.

CHAS. J. ALLEN,
Major of Engineers, U. S. A.

A A 14.

PRELIMINARY EXAMINATION OF RED RIVER OF THE NORTH, MINNESOTA, FROM MOORHEAD TO FERGUS FALLS.

ENGINEER OFFICE, UNITED STATES ARMY,
Saint Paul, Minn., December 3, 1886.

GENERAL: I have the honor to report as follows upon the preliminary examination of the Red River of the North from Moorhead to Fergus Falls, Minn., made in accordance with the requirements of sections 6 and 7 of the river and harbor act of Congress approved August 5, 1886.

Fergus Falls is on the Otter Tail River, and about 70 miles, by water, above its mouth. The Otter Tail and the Bois-de-Sioux River, which has its rise in Lac Travers, unite at Breckenridge, forming the Red River of the North. Moorhead is about 40 miles north of Breckenridge, by land, and 101 miles distant from it by the channel of the Red River.

The Red River between Moorhead and Breckenridge was thoroughly surveyed in 1874, and its improvement is included in the project for the general improvement of the river from Breckenridge to the northern boundary line. The plan for improvement of this section contemplates the removal of snags, bowlders, and leaning timber, and the contraction of the low-water way upon the 13 miles of river just below (north of) Breckenridge, by means of brush wing-dams. During the winter of 1879-'80 a force of men removed large numbers of snags and leaning trees between Moorhead and McCauleyville—the latter-named about 75 miles above Moorhead—thus improving this part of the river for high-water navigation; with this exception no work of improvement has been undertaken south of Moorhead.

For about 10 miles below Fergus Falls the Otter Tail River is full of bowlders; the descent is sharp, and a number of small rapids occur. In the next 10 miles the slope reduces, although the current is rapid, and the bed of the stream is obstructed by large quantities of bowlders. During high-water stages small flat-boats with light loads have run down this 10-mile section, but at great risk. The remainder of the river to Breckenridge, about 50 miles in distance, is comparatively sluggish, with depth of about 3 feet, and average width of 70 feet at ordinarily low-water stage. In former years steam-boats of fair size have navigated this section of the stream during high stages of water, and numbers of flat-boats laden with flour, coal, lumber, etc., were run from the upper end of this section to Pembina and other points on the Red River. This navigation appears, however, to have been discontinued during the past three years.

To render the first 20 miles of the Otter Tail River, below Fergus Falls, navigable, locks and dams would have to be resorted to, at an expense apparently entirely out of proportion to the demands of navigation or to any public benefit to be derived from such improvement. The improvement of the Red River of the North, from Moorhead to Breckenridge, will practically open navigation from the former to within 20 miles of Fergus Falls, and this can be accomplished by means of liberal appropriations for improving the Red River of the North. While, therefore, the Red River from Moorhead to Breckenridge is well worthy of improvement by the General Government, no further survey of the route is required.

STATISTICS.

Under this head, Assistant Engineer R. Davenport, who examined the route in November, reports:

> The country south of Moorhead naturally tributary to the Red River is rapidly increasing in population, and the area cultivated is each year being largely extended. Within the last three or four years the facilities for moving the crops, etc., by rail have been considerably increased, but the rates are still exceedingly high, nearly 3 to 1 as compared with some other localities in Minnesota. The improvement of the Red River, as yet not continuous, can now only be said to be of local benefit, though the completion of the improvement of the Red River from Breckenridge to the boundary line cannot fail to be of great general benefit to that entire section of country.
>
> Of the country immediately tributary to the river between Fergus Falls and Moorhead, the following statistical information was collected:
>
> Town of Fergus Falls, population 4,285. Population of Otter Tail County, 33,000; total acreage in county, 1,270,977 acres; area cultivated, 152,600 acres; hay lands, 40,000 acres. The wheat crop of 1886 is estimated at 1,775,537 bushels; oats at 939,061 bushels.

In the limits of Fergus Falls there are five dams for water-power, with heads from 7 feet to 17 feet; a combined head of 64 feet. The manufactories consist of five flour-mills, with a total capacity of 1,525 barrels of flour per day; one 10-ton paper-mill; sash, door, and blind factories, etc.

Breckenridge has a population of 700. Population of Wilkin County, 4,000; total acreage in county, 476,387; acreage cultivated about 75,000; hay lands, about 10,000; wheat crop estimated at 1,000,000 bushels; oats, barley, etc., about 400,000 bushels.

Wahpeton, population 2,200. Richland County, population 11,000; estimated acreage of county, 836,950; acreage cultivated, 150,000; wheat crop estimated at 1,500,000 bushels; oats, barley, etc., 250,000. Wahpeton has one flour-mill of 100 barrels daily capacity.

Fargo has a population of 8,206. Population of Cass County, 21,085; acreage in county, 911,795; acreage cultivated, about 425,000; wheat crop estimated at 5,554,845 bushels; oats, barley, etc., 1,166,550 bushels.

Population of Moorhead, 3,500. Population of Clay County, 10,500; acreage cultivated, 96,087; wheat crop estimated at 1,000,000 bushels; oats, barley, etc., 500,000 bushels.

It was found very difficult to obtain reliable statistical information, and comparative statistics showing the annual increase, etc., were out of the question. All the information possible was, however, obtained from the most reliable sources, and will serve to show the great advance in a locality that fifteen years ago was an actual wilderness.

The country south of Moorhead, in the vicinity of the Red River, is mostly level prairie, and, with the exception of narrow belts of timber along the river bottom, perfectly open.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

INDEX.

Subject.	Page. Part I.	Part II.	Part III.	Part IV.
A.				
ate Bay Harbor, Minn., improvement of	255		1951	
visory Harbor Commission at Philadelphia	85 820			
napee Harbor, Wis., improvement of	202		2037	
abama River, improvement of	170	1288		
legheny River, Pa., improvement of	239		1810	
legheny River, dam at Herr's Island, construction of	239		1811	
ligator River, S. C., examination and survey of	139	1114		
ligator River, N. C., examination of	123	991		
tamaha River, Ga., improvement of	149	1176		
nite River, La., improvement of	181	1364		
guille River, Ark., improvement of	209	1543		
napolis Harbor, Md., improvement of	98 863			
palachicola Bay, Fla., improvement of	163	1265		
palachicola River, improvement of	162	1263		
ppomattox River, Va., improvement of	117	978		
queduct Bridge, Georgetown, D. C., construction of	104 898			
ransas Pass and Bay, Tex., improvement of	191	1431		
rcher's Hope River, Va., improvement of	117	977		
rkansas River, operations of snag-boats on	204	1505		
rkansas River, at Pine Bluff, improvement of	205	1515		
rthur Kill Bridge, Staten Island Sound, report of Board of Engineers on	837			2682
rkansas River, improvement of	205	1510		
rkansas River, survey of. from Little Rock to mouth	206	1528		
snley River, S. C., improvement of	142	1141		
shland Harbor, Wis., improvement of	256		1957	
shtabula Harbor, Ohio, improvement of	302		2327	
tlantic City, N. J., survey of harbor of	85 814			
u Sable Harbor, Mich., improvement of	289		2250	
B.				
altimore Harbor, improvement of entrance to	97 860			
altimore Harbor, Md., examination and survey for widening channel to 600 feet	101 880			
angor Harbor, Me., improvement of	16 442			
ar at mouth of Limestone Creek, Maysville Harbor, Ky., examination of	244		1834	
ar Harbor, Me., examination and survey, with view to establishing a breakwater	22 481			
ath, Me., Kennebec River at, examination and survey	22			
attalion of Engineers	12 419			
attery Island, head of Chesapeake Bay, piers at	99 864			
ayoduce River, Me., between Penobscot and Brooksville, examination of	22			
ayou Boeuf, La., improvement of	196	1461		
ayou Black, La., improvement of	183	1368		
Bayou Bartholomew, La. and Ark., improvement of	196	1459		
Bayou D'Arbonne, La., improvement of	195	1458		
Bayou Courtableau, La., improvement of	184	1375		
Bayou La Fourche, La., examination for lock and dam at mouth of	188			
Bayou Macon, La., improvement of	197	1463		
Bayou La Fourche, La., improvement of	182	1365		
Bayou Pierre, Miss., improvement of	185	1382		
Bayou Pierre, La., survey of	194	1453		
Bayou Plaquemine, La., and other connecting streams, for route to Grand Lake, examination and survey of	188	1405		
Bayou Plaquemine, La., mouth of, for connection with Mississippi River by locks, examination and survey of	188	1405		
Bayou Rondeway, La., examination of	203	1497		
Bayou Rouge, La., examination and survey of	188	1393		
Bayou Teche, La., improvement of	183	1370		
Bayou Teche, La., connection with Grand Lake	184	1374		
Bayou Teche, La., from Saint Martinsville to Fort Barre, examination of	188			
Bayou Terrebonne, La., improvement of	182	1367		

SUBJECT.	Page.			
	Part I.	Part II.	Part III.	Part IV.
Bayou Terrebonne, La., from Houma to Thibodeaux, examination and survey of	188	1396		
Bayou Vermillion, La., from Abbeville to railroad bridge of Louisiana and Texas Railroad, examination of	188	1398		
Bayou Vidal, La., examination of	203	1497		
Beaufort Harbor, N. C., improvement of	128	1030		
Bear Creek, Miss., examination of	236			
Beaufort Harbor, inland water-way to New Berne, N. C., improvement of	127	1026		
Belfast Harbor, Me., improvement of	16 445			
Beaufort Harbor, inland water-way to New River, N. C., improvement of	129	1037		
Bellamy River, N. H., examination and survey of	22 464			
Bell River, Mich., ice harbor of refuge at	291		2262	
Biddle's Point, Mackinac Harbor, Mich., examination with view to a breakwater	294		2271	
Big Hatchee River, Tenn., improvement of	201	1479		
Big Hockhocking River, Ohio, from mouth to Coolville, examination of	244		1835	
Big Rapids, St. John's River, Me., examination of	21 471			
Big Sandy River, W. Va. and Ky., improvement of	241		1823	
Biloxi Bay, Miss., improvement of harbor at	176	1333		
Big Sunflower River, Miss., improvement of	200	1477		
Big Black River, Miss., improvement of	198	1465		
Black Lake Harbor, Mich., improvement of	282		2194	
Black River, Ark. and Mo., improvement of	208	1537		
Black Rock Harbor, Conn., improvement of	49 613			
Black River Harbor, Ohio, improvement of	299		2312	
Black River, Saint Clair County, Mich., examination of mouth of	294		2279	
Black River, N. C., improvement of	130	1042		
Black Warrior River, Ala., improvement of	172	1299		
Black Water River, Va., improvement of	120	987		
Block Island, R. I., construction of harbor at	40 558			
Board of Engineers, for fortifications and for river and harbor improvements	5			
Bogue Falia, La., examination of	188			
Boston Harbor, Mass., improvement of	26 511			
Brazos River, Tex., improvement of mouth of	191	1427		
Brazos Santiago, Tex., improvement of harbor at	194	1433		
Breakwater at Cleveland, Ohio, construction of	300		2319	
Breakwater, New Haven, Conn., construction of	47 602			
Breton Bay, Md., improvement of	167 929			
Bridge at Arthur Kill, Staten Island Sound	337			[illegible]
Bridging the Mississippi River at Saint Louis, Report Board of Engineers	338			[illegible]
Bridge, construction of aqueduct, at Georgetown, D. C	104 898			
Bridge across Eastern Branch Potomac River, Washington, D. C	105 911			
Bridging navigable waters of the United States	337			[illegible]
Bridge, Ohio River, at Beaver, Pa., guiding-dike at	338			[illegible]
Bridgeport Harbor, Conn., improvement of	49 610			
Bridge at Cincinnati of the Kentucky and Ohio Bridge Company	337			2653
Bridge, Willamette River, Portland, Oregon	339			2661
Bridge, Willamette River, Salem, Oregon	339			[illegible]
Bridge, Red River, Shreveport, La., removal of sand bar against piers of	339			[illegible]
Brigantine Beach, N. J., channel between Absecon and Brigantine Inlets, examination of	86 821			
Broad Creek, Del., improvement of	95 843			
Broadkiln River, Del., improvement of	90 834			
Brunswick Harbor, Ga., improvement of	151	1184		
Buckhannon River, W. Va., improvement of	243		1832	
Buffalo Bayou, Tex., improvement of	190	1423		
Buffalo Harbor, N. Y., improvement of	305		2351	
Burlington Harbor, Vt., improvement of	315		2406	
Buttermilk Channel, N. Y., improvement of	60 703			

C.

Cache River, Ark., examination of	210	1547		
Cahawba River, Ala., improvement of	170	1287		
Calcasieu River and Pass., La., examination of	188	1402		
Calcasieu River and Pass, La., improvement of	185	1378		
Caloosahatchie River, Fla., improvement of	157	1235		
Calumet Harbor, Ill., improvement of	273		2117	
Calumet River, Ill., from Riverdale to Blue Island, examination of	277			
Calumet River, Ill., and Ind., improvement of	275		2167	

Subject.	Page.				
	Part I.		Part II.	Part III.	Part IV.
ambridge Harbor, Md., examination and survey of	97	851			
amden Harbor, Me., examination and survey of	22				
anal at the Cascades, Columbia River, Oregon, construction of	828			2476	
anal at Des Moines Rapids, Mississippi River	219		1639		
anal, Illinois and Michigan, report on acquisition of	275			2125	
anal, Louisville and Portland, report on dry dock at	249			1896	
anal, Louisville and Portland, operating and care of	245			1843	
anal, St. Mary's Falls, Mich., construction of	286			2214	
anarsie Bay, N. Y., improvement of	64	737			
aney Fork River, Tenn., examination and survey of		236		1768	
ane River, La., improvement of		194	1452		
aney Fork River, Tenn., improvement of		235		1766	
ape Fear River, N. C., improvement of entrance to		132	1047		
ape Fear River, above Wilmington, improvement of		131	1044		
arp River, Leland, Mich., examination of, for entrance to Carp Lake for harbor of refuge		286		2208	
assity Bayou, Miss., examination of		203	1497		
atawba River, N. C., examination and survey of		139			
edar Bayou, Tex., examination of, where it empties into Galveston Bay		193	1485		
edar Keys Harbor, Fla., improvement of		161	1251		
edar River Harbor, Mich., improvement of		259		2002	
hagrin River, Ohio, examination at mouth of		303		2333	
hannel back of Brigantine Beach, N. J., between Absecon and Brigantine Inlets, examination of	86	821			
hannel between Jamaica Bay and Rockaway Inlet, N. Y., examination and survey of	67	754			
Channel between Staten Island and New Jersey, improvement of	65	748			
Channel, Torch Lake, Lake Superior, examination of	266			2053	
Charleston Harbor, S. C., improvement of		140	1125		
Charlevoix Harbor, Mich., improvement of		277		2176	
Charlotte Harbor, Fla., including San Carlos Bay, examination and survey of		162	1258		
Charts N. and NW. Lakes, printing and distribution of		343			3148
Charlotte Harbor, N. Y., improvement of		308		2371	
Chattahoochie River, Ala. and Ga., improvement of		169	1283		
Cheboygan Harbor, Mich., improvement of	288			2247	
Cheesequakes Creek, N. J., improvement of	73	775			
Chehalis River, Wash., improvement of	328			2489	
Chester River, Md., improvement of, at Kent Island Narrows	93	838			
Chicago Harbor, Ill., improvement of	272			2109	
Chickahominy River, Va., improvement of	111	947			
Chincoteague Bay, Va., inland water-way to Lewes, Del., improvement of	91	836			
Chippewa River, Wis., examination and report on overflows on	229		1726		
Chippewa River at Yellowbanks, Wis., improvement of	226		1703		
Chippewa River, Wis., improvement of	225		1699		
Choctawhatchee River, Fla. and Ala., improvement of	165		1271		
Choptank River, Md., improvement of	94	840			
Cincinnati, Ohio, ice harbor at	241			1822	
Clark's Creek, S. C., examination and survey of	139		1109		
Clear Water Harbor, Fla., examination of	162		1259		
Clearwater River, Idaho, improvement of	332			2523	
Cleveland Harbor, Ohio, improvement of	300			2317	
Clinch River, Tenn., improvement of	238			1755	
Clinton River, Mich., improvement of	293			2265	
Clinton Harbor, Conn., improvement of	46	596			
Coal River, W. Va., examination of	253			1929	
Coanjok Bay, N. C., improvement of	119		986		
Cocheco River, N. H., improvement of	20	466			
Cohansey Creek, N. J., improvement of	84	812			
Colorado of the West, improvement of	324			2449	
Columbia River, Upper, improvement of	332			2520	
Columbia River, Lower, Oregon, improvement of	831			2507	
Columbia River Oregon, canal at Cascades	828			2476	
Columbia River, Oregon, improvement of mouth of	327			2470	
Congaree River, S. C., improvement of	138		1093		
Conecuh River, Ala., improvement of	165		1273		
Contingencies of rivers and harbors, estimates for	333				
Conneaut Harbor, Ohio, improvement of	303			2332	
Connecticut River, above Hartford, Conn., improvement of	44	587			
Connecticut River, below Hartford, Conn., improvement of	45	590			
Coosa River, Ga., and Ala., improvement of	168		1281		
Contentnia Creek, N. C., improvement of	124		1013		
Coos Bay, Oregon, improvement of entrance to	825			2460	
Coosawattee River, Ga., improvement of	167		1278		
Coquille River, Oregon, between Coquille City and Myrtle Point, examination of	330			2498	
Coquille River, Oregon, improvement of mouth of	825			2458	

Subject.	Page. Part I.		Page. Part II.	Page. Part III.	Page. Part IV.
Cornay River, La., examination of	203		1489		
Cottage City Harbor, Mass., examination of	43	568			
Corsica Creek, Md., improvement of	93	838			
Corpus Christi, Tex., improvement of channel to	191		1431		
Courtableau Bayou, La., improvement of	184		1375		
Cowlitz River, Wash., improvement of	333			2524	
Crescent City Harbor, Cal., examination of, for a sea-wall from Battery Point to Flat Rock	324			2454	
Cumberland River, Ky., improvement of south fork of	235			1765	
Cumberland River, Tenn. and Ky., improvement of	233			1758	
Cumberland Sound, Fla. and Ga., entrance to, improvement of	152		1191		
Currituck Sound, improvement of	119		986		
Cypress Bayou, La., examination of	203		1494		
Cypress Bayou, Tex., improvement of	194		1453		
D.					
Dan River, Va., improvement of	112	953			
Darby Creek, Pa., examination and survey of	86	822			
D'Arbonne Bayou, La., improvement of	195		1458		
Davis's Island Dam, Ohio River, operating and care of	238			1796	
Defenses, sea-coast and lake frontier	4				
Delaware Breakwater Harbor, improvement of	81	805			
Delaware River, Pa. and N. J., improvement of	76	786			
Des Moines Rapids Canal, Mississippi River	219		1639		
Des Moines Rapids Canal, operating and care of	220		1644		
Detroit River, Mich., improvement of	293			2266	
Doboy Bar, Ga., improvement of	150		1179		
Doboy Bar to Doboy Island, Ga., examination and survey of	154		1199		
Des Moines Rapids Canal, dry-dock at	221		1651		
Dubuque, Iowa, improvement of harbor at	221		1653		
Dubuque, Iowa, ice-harbor at	222		1656		
Duck Creek, Del., improvement of	89	831			
Duck Creek, Del., examination and survey of	97	847			
Duck Island Harbor, Long Island Sound, Conn., examination of, for harbor of refuge	56	641			
Duck River, Tenn., improvement of	233			1757	
Dugdemona River, La., examination of	203		1489		
Duluth Harbor, Minn., improvement of	253			1935	
Dunkirk Harbor, N. Y., improvement of	304			2348	
Duties and rank of officers of the Corps of Engineers	347				
Duxbury Harbor, Mass., examination and survey of	31				
E.					
Eagle Harbor, Mich., improvement of	257			1970	
East Chester Creek, N. Y., improvement of	53	628			
East River, N. Y., removal of obstructions from	59	689			
Eastern Branch, Potomac River, bridge over, at Washington, D. C	105	911			
Echo Harbor, New Rochelle, N. Y., improvement of	52	624			
Edenton Bay, N. C., improvement of	122		989		
Edisto River, S. C., improvement of	143		1143		
Edisto River, S. C., examination of North Fork of	154				
Elizabeth River, N. J., improvement of	69	768			
Elk River, W. Va., improvement of	251			1928	
Engineer Depot	13	423			
Engineer School of Application	12	415			
Erie Harbor, Pa., improvement of	304			2343	
Escambia River, Ala. and Fla., improvement of	165		1273		
Evansville, Ind., Ohio River near, examination of	244				
Examinations, surveys, and contingencies of rivers and harbors, estimates for	333				
Explorations and reconnaissances	344				
Explorations and surveys, Department of California	344				3147
Explorations and surveys in Department of Dakota	345				3149
Explorations and surveys in Division of the Missouri	344				3145
Explorations and surveys in Division of the Pacific	344				3147
Explorations and surveys, Department of the Columbia	345				3152
Explorations and reconnaissances, estimates for	346				
F.					
Fairlee Creek, Md., examination of	97	854			
Fairport Harbor, Ohio, improvement of	302			2324	
Falls of the Ohio River, improvement of navigation at	244			1838	
Falls of St. Anthony, Minn., preservation of	223		1660		
Falmouth Harbor, Mass., examination of	43	567			
Farm Creek, Ill., examination of, with view to changing its course	277			2171	

Subject.	Page. Part I.	Page. Part II.	Page. Part III.	Page. Part IV.
Feather and Sacramento rivers, Cal., improvement of	822		2421	
Fish-ways, Falls of the Potomac, erection of	835			2564
Five-Mile River Harbor, Conn., examination and survey of	56 639			
Flint River, Ga., from Montezuma to Old Agency, examination and survey of	171	1290		
Flint River, Ga., improvement of	167	1278		
Flushing Bay, N. Y., improvement of	55 634			
Forestville, Lake Huron, Mich., examination of, for harbor at	294		2273	
Forked Deer River, Tenn., examination of North Fork, below Dyersburgh	203	1494		
Fort Brown, Tex., protection of river bank at	192	1434		
Fortifications, estimates	5			
Fourche River, Ark., improvement of	207	1531		
Fox and Wisconsin rivers, improvement of	270		2077	
Fox River, improvement, operating, and care of	272		2108	
Frankford Creek, Pa., improvement of	78 799			
Frankfort Harbor, Mich., improvement of	278		2179	
French Broad River, N. C., improvement of	113 958			
French Broad River, Tenn., improvement of	231		1751	
Fulton, Ark., lakes connecting with Red River, between Shreveport, Ark., and, examination of	203	1490		
G.				
Galveston Bay, ship channel in, improvement of	189	1417		
Galveston Harbor, Tex., improvement of entrance to	189	1415		
Gasconade River, Mo., improvement of	214	1590		
Gauley River, W. Va., examination of	253			
Gedney's Channel, New York Harbor, improvement of	62 718			
Georgetown Harbor, S. C., improvement of	135	1074		
Georgetown and Washington harbors, D. C., improvement of	101 883			
Gilbert's Bar, Indian River, Fla., survey of channel from Haulover to	162	1261		
Gloucester Harbor, Mass., improvement of	25 500			
Glen Cove Harbor, N. Y., examination of	56 645			
Gowanus Bay, N. Y., improvement of	61 709			
Grand Haven Harbor, Mich., improvement of	281		2191	
Grass River at Massena, N. Y., improvement of	313		2396	
Grand Marais Harbor, Mich., improvement of	258		1999	
Grand Marais, Minn., improvement of harbor at	255		1954	
Grand River, Mich., improvement of	282		2193	
Grand River, Mich., examination of	286		2206	
Grand Traverse Bay, Mich., for connection with Torch Lake near Eastport, examination of	286		2210	
Great Kanawha River, W. Va., harbor of refuge at mouth of	241		1822	
Great Kanawha River, W. Va., improvement of	249		1911	
Great Pee Dee River, S. C., improvement of	135	1070		
Great Sodus Harbor, N. Y., improvement of	309		2376	
Green Bay Harbor, Wis., improvement of	261		2012	
Greenport Harbor, N. Y., improvement of	54 630			
Guyandotte River, W. Va., improvement of	242		1827	
Green and Barren River Navigation Company, value of property of	249		1903	
Gordon's Landing, Lake Champlain, breakwater at	314		2400	
H.				
Hamburgh Bay, Ill., bars in, examination of	218	1616		
Harbor of refuge, mouth of Great Kanawha River, W. Va., construction of	241		1822	
Harbor of refuge, Sandy Bay, Mass	24 497			
Harbor of refuge, Sand Beach, Lake Huron, Mich	290		2256	
Harbor of refuge, Long Island, Conn., resurvey of Duck Island for	56 641			
Harbor of refuge near Cincinnati, Ohio, construction of	241		1822	
Harbor of refuge, Sturgeon Bay Canal, Wis	262		2014	
Harlem River, N. Y., improvement of	58 665			
Hay Lake Channel, St. Mary's River, improvement of	287		2238	
Haulover, on Indian River, Fla., survey of channel from, to Gilbert's Bar	162	1261		
Hero Islands, Lake Champlain, examination of channel at	317		2412	
Hell Gate, N. Y., improvement of navigation at	59 689			
Hiawassee River, Tenn., improvement of	232		1754	
Hingham Harbor, Mass., improvement of	28 520			
Housatonic River, Conn., improvement of	48 606			
Holston River, Tenn., examination and survey of	236		1772	
Hudson River, N. Y., between New Baltimore and Coxsackie, examination and survey of	67			
Hudson River, N. Y., improvement of	56 650			
Hudson, Wis., harbor at, examination of	229	1723		

SUBJECT.	Page.				
	Part I.		Part II.	Part III.	Part IV.
Humboldt Harbor and Bay, Cal., improvement of	323			2447	
Hunter's Creek, Va., examination of	114	962			
Huron Harbor, Ohio, improvement of	298			2307	
Hyannis Harbor, Mass., improvement of	31	532			
Hydraulic mining, Sacramento and Feather rivers, suppression of	323			2444	
I.					
Ice-harbor at Dubuque, Iowa, construction of	222		1656		
Ice-harbor at Cincinnati, Ohio, construction of	241			1822	
Ice-harbor at head of Delaware Bay, Del., construction of	80	804			
Ice-harbor at mouth of Muskingum River, construction of	240			1813	
Ice-harbor at Marcus Hook, Pa., construction of	79	802			
Ice-harbor at Newcastle, Del., construction of	88	829			
Illinois River, improvement of	274			2119	
Indian River, Del., improvement of	91	835			
Indian River, Fla, survey of channel from Haul-over to Gilbert's Bar	162		1261		
Inland water-way from Chincoteague Bay to Delaware Bay	91	836			
Inside passage between Fernandina and St. John's River, Fla., improvement of	153		1199		
Inland navigation from New Berne and Beaufort, N. C., improvement of	127		1027		
Ivy Landing, Ill., Mississippi River at, examination of	215				
Ipswich River, Mass., improvement of	24	495			
Inland water-way between Beaufort and New River, N. C., improvement of	129		1037		
Indiana Chute, Falls of the Ohio, improvement of	245			1842	
Illinois and Michigan Canal, report on acquisition of, and construction of Hennepin Canal	275			2125	
J.					
James River, Dak., examination of	217		1603		
James River, Va., improvement of	100	867			
Jamaica Bay, N. Y., channel between Rockaway Inlet and, examination of	67	754			
Jonesport, Me., improvement of Moose-a-beck Bar at	15	438			
Jekyl Creek, Ga., examination and survey of	154				
K.					
Kanawha River, Great, improvement of	249			1911	
Kanawha River, Little, improvement of	242			1828	
Kaskaskia River, Ill., from New Athens to its mouth, examination and survey of	215				
Kennebec River, Bath and Augusta, Me., examination of	22				
Kennebunk River, Me., improvement of	19	461			
Kenosha Harbor, Wis., improvement of	268			2072	
Kent Island Narrows, Md., improvement of	93	838			
Key West Harbor, Fla., survey of entrance to	156		1221		
Kentucky River, Ky., improvement of	247			1872	
Keyport Harbor, N. J., improvement of	73	776			
Kentucky River, Ky., operating and care of locks and dams on	248			1885	
Kewaunee Harbor, Wis., improvement of	263			2040	
L.					
Lake City, Minn., harbor of refuge at		222	1657		
Lagrange Bayou, Fla., improvement of		164	1268		
Lake harbors, and rivers		253			
La Fourche Bayou, La., improvement of		182	1365		
Lake Huron, Mich., harbor at Forestville, examination and survey of		294		2273	
Lake Champlain, Narrows, N. Y., and Vt, improvement at		316		2411	
Lake Michigan, at Empire, with a view to cutting channel across the bar to Bar Lake, examination of		286		2209	
Lake Pepin, harbors of refuge on		222	1657		
L'Anguille River, Ark., improvement of	209		1543		
Laws of Forty-ninth Congress, second session, affecting Corps of Engineers	371				
Leonardtown Harbor, Md., improvement of	107	929			
Lewes, Del., construction of piers at	80	804			
Licking River, Ky., from Farmers' to West Liberty, examination of	249			1902	
Link River, Oregon, examination of	330				
Little Harbor, N. H., improvement of	21	408			
Little Kanawha River, W. Va., improvement of	242			1828	
Little Narragansett Bay, R. I. and Conn., improvement of	41	561			

Subject.	Page. Part I.	Page. Part II.	Page. Part III.	Page. Part IV.
ittle Narragansett Bay, R. I., entrance to wharves at Watch Hill, examination and survey of	43 571			
ttle Pee Dee River, S. C., examination and survey of	139	1111		
ttle River, Ark., re-examination of	210	1545		
ttle Tennessee River, Tenn., improvement of	232		1752	
ttle River, La., examination of	203	1498		
ttle Red River, Ark., improvement of	204	1503		
ttle River, Mo., from Hornersville to its junction with the Saint Francis River, examination of	210	1548		
ittle Sodus Harbor, N. Y., improvement of	310		2379	
oggy Bayou, Lake Bistoneau, and the Dorcheat, La., improvement of	195	1454		
ockwood's Folly River, N. C., examination and survey of	139	1099		
ouisa Fork of Sandy River, Va., examination of	249		1902	
ouisville and Portland Canal, Ky., report on dry-dock at	249		1896	
ouisville and Portland Canal, report on drainage rights	246		1852	
ouisville and Portland Canal, operating and care of	245		1843	
ower Willamette and Columbia rivers, Oregon, improvement of	331		2507	
ubec Channel, Me., improvement of	14 436			
uddington Harbor, Mich., improvement of	279		2184	
umber River, N. C., examination and survey of	139	1102		
ynn Harbor, Mass., improvement of	25 508			
M.				
ackinac Harbor, Mich., at Biddle's Point, with view to a breakwater, examination of	294		2271	
alden River, Mass., improvement of	28 520			
amaroneck Harbor, N. Y., improvement of	52 622			
anasquan River, N. J., improvement of	75 782			
anistique Harbor, Mich., improvement of	259		2001	
anchester Harbor, Mass., examination and survey of	31			
anatee River, Fla., improvement of	158	1239		
anistee Harbor, Mich., improvement of	279		2182	
antua Creek, N. J., improvement of	83 809			
anitowoc Harbor, Wis., improvement of	264		2044	
Maps, military and geographical, compilation of	844			
Marcus Hook Harbor, Pa., improvement of	79 802			
Marquette Harbor, Mich., improvement of	257		1995	
Matagorda Bay., Tex., improvement of entrance to	191	1429		
Mattaponi River, Va., improvement of	109 940			
Matinicus Isle, Me., examination and survey with view to a harbor of refuge	21 475			
Mattawan Creek, N. J., improvement of	74 777			
Mattox Creek, Va., examination and survey of	114 959			
Maurice River, N. J., improvement of	86 826			
Maysville Harbor, Ky., bar at mouth of Limestone Creek at, examination of	244		1834	
Meadow River, W. Va., examination of	253			
Meherin River, Va., improvement of	121	989		
Meeker's Island, Minn., lock and dam at	223	1663		
Menemaha, Mass., harbor, examination and survey of	43 568			
Menomonee Harbor, Mich. and Wis., improvement of	260		2004	
Merrimac River, Mass., improvement of	23 493			
Michigan City Harbor, Ind., improvement of	284		2202	
Milford Harbor, Conn., improvement of	48 604			
Milwaukee Bay, harbor of refuge at	266		2055	
Milwaukee Harbor, Wis., improvement of	267		2061	
Mingo Creek, S. C., examination and survey of	139	1106		
Minnesota River, improvement of	227	1710		
Minnesota River, with a view to its improvement by locks and dams, examination and survey of	229			
Mispillion Creek, Del., improvement of	90 833			
Mississippi River:				
above the Falls of St. Anthony, improvement of	224	1664		
at Des Moines Rapids, improvement of	219	1639		
at Dubuque, Iowa, improvement of	221	1653		
at Falls of Saint Anthony, improvement of	223	1660		
at Ivy Landing, Ill., examination and survey of	215			
operations of snag-boats on	210	1553		
at Rock Island Rapids, improvement of	217	1607		
at Rush Island Bend, Ill., examination and survey of	215			
improvement of South Pass, inspection of	178	1345		
between the mouths of the Illinois and Ohio rivers, improvement of	211	1556		
between Saint Paul and Saint Anthony's Falls, survey of	230			
from Des Moines Rapids to the mouth of Illinois River, improvement of	217	1607		
from Saint Paul to Des Moines Rapids, improvement of	219	1623		
Upper, operations of snag-boats on	218	1617		

SUBJECT.	Page.				
	Part I.		Part II.	Part III.	Part IV.
Mississippi River Commission:					
annual report for the fiscal year ending June 30, 1886	340				[illegible]
report of November 30, 1886	340				[illegible]
annual report for the fiscal year ending June 30, 1887	340				[illegible]
Missouri River:					
operations of snag-boats on	211		1555		
from Sioux City to Fort Benton, Mont., improvement of	215		1597		
Missouri River Commission:					
annual report fiscal year June 30, 1886	341				[illegible]
annual report fiscal year June 30, 1887	341				[illegible]
Mobile Harbor, Ala., improvement of	171		1293		
Monongahela River, lock and dam No. 9, operating and care of.	239			1809	
Monongahela River, improvement of	238			1800	
Monroe Harbor, Mich., improvement of	294			2281	
Mount Vernon, Va., improvement of channel at	106	927			
Moose-a-bec Bar, Jonesport, Me., improvement of	15	438			
Mokelumne River, Cal., improvement of	321			2441	
Mosquito Creek, S. C., examination and survey of	154				
Movable dam at Davis' Island, Ohio River, operating and care of	238			1796	
Muskegon Harbor, Mich., improvement of	281			2189	
Muskingum River, Ohio, ice harbor at mouth of	240			1813	
Muskingum River, Ohio, operating and care of locks and dams on	240			1815	
N.					
Nansemond River, Va., examination and survey of	123		995		
Nantucket Harbor, Mass., improvement of	32	534			
Narragansett Bay, R. I., improvement of	37	550			
Narraguagus River, Me., improvement of	15	441			
Nanticoke River, Del., improvement of	94	842			
Neabsco Creek, Va., improvement of	106	928			
Neches River, Tex., improvement of	186		1384		
Nehalem Bay and Bar, Oregon, examination of	330			2496	
Neuse River, N. C., improvement of	126		1020		
New Bedford Harbor, Mass., examination and survey of	43				
Newburyport Harbor, Mass., improvement of	22	489			
New Castle, Del., ice-harbor at	88	829			
New Haven Harbor, Conn., improvement of	46	597			
New London Harbor, Conn., improvement of	44	585			
New River, N. C., improvement of	129		1039		
New River, Va. and W. Va., improvement of	251		1925		
Newport Harbor, Cal., survey of	320				
New Rochelle, N. Y., improvement at	53	626			
Newport Harbor, R. I., improvement of	38	554			
Newtown Creek, N. Y., improvement of	60	699			
New York Harbor, improvement of	62	717			
Niagara River, N. Y., between Black Rock and Tonawanda, for a 16-foot channel, examination of	308				
Niagara River, N. Y., near Tonawanda Island, improvement of.	306			2366	
Nomini Creek, Va., improvement of	107	932			
Norfolk Harbor, Va., improvement of	114		963		
Norfolk Harbor, Va., approaches to, improvement of	115		969		
North Fork Forked Deer River, Tenn., below Dyersburg, examination of	203		1494		
North Landing River, Va. and N. C., improvement of	119		984		
North and South Hero islands, Lake Champlain, examination of channel between	317			2412	
North River Bar, Currituck Sound, N. C., improvement of	119		986		
Nootsack River, Wash., improvement of	329			2490	
North River, Mich., between Essex and North Bridges, examination of	294			2271	
Norwalk Harbor, Conn., improvement of	50	616			
Nottoway River, Va., improvement of	121		988		
Noxubee River, Miss., improvement of	175		1328		
Noxubee River, Miss., examination of, for locks and dams	178		1343		
O.					
Oakland Harbor, San Francisco Bay, Cal., improvement of	317			2419	
Oak Orchard Harbor, N. Y., improvement of	307			2369	
Obeil's River, Tenn., examination of, from existing improvements to mouth of West Fork	236				
Ocmulgee River, Ga., improvement of	167		1278		
Oconee River, Ga., improvement of	166		1275		
Oconto Harbor, Wis., improvement of	260			2006	
Office of the Chief of Engineers	345				
Officers of the Corps of Engineers, number of, duties of	3	347			
Ogdensburgh Harbor, N. Y., improvement of	312			2393	

SUBJECT.	Page.				
	Part I.		Part II.	Part III.	Part IV.
Ohio River, improvement of	236			1782	
Ohio River, improvement of Falls of	244			1838	
Ohio River, survey of, near Evansville, Ind	244				
Olcott Harbor, N. Y., improvement of	307			2368	
Old Town Creek, Miss., improvement of	174		1327		
Ontonagon Harbor, Mich., improvement of	256			1967	
Oostenaula River, Ga., improvement of	167		1278		
Osage River, Mo. and Kans., improvement of	214		1591		
Osage River, Mo., from its mouth to Osceola, resurvey of	215		1593		
Oswego Harbor, N. Y., improvement of	310			2381	
Otter Creek, Vt., improvement of	315			2410	
Ouachita and Black Rivers, Ark. and La., improvement of	195		1455		
Ouachita River, re-examination of, above Camden	203		1495		
Ouachita River, La., from Camden to mouth, with a slackwater navigation, examination of	208		1487		
P.					
Paducah, Ky., examination for ice-harbor at	243			1833	
Pamlico and Tar Rivers, N. C., improvement of	123		1010		
Pamunkey River, Va., improvement of	110	942			
Pascagoula River, Miss., improvement of	175		1330		
Passaic River, N. J., improvement of	68	783			
Pass Cavallo, Tex., improvement of	191		1429		
Patapsco River, Md., improvement of	97	860			
Patchogue River, N. Y., mouth of, examination and survey of	67	759			
Patuxent River, Md., from Benedict to Hill's Landing, examination and survey of	114				
Pawcatuck River, R. I., improvement of	42	565			
Pawtucket River, R. I., improvement of	36	548			
Pease River, Fla., improvement of	158		1237		
Pearl River, Miss., improvement of	176 177		1334 1336 1339		
Pee Dee River, Great, S. C., improvement of	135		1070		
Penobscot River, Me, improvement of	16	442			
Penobscot River, from Bangor to Bucksport Narrows, examination and survey of	22				
Pensacola, Fla., resurvey of outer and inner bars at	171				
Pensaukee Harbor, Wis., improvement of	261			2010	
Pensacola Harbor, Fla., improvement of	164		1269		
Pentwater Harbor, Mich., improvement of	280			2186	
Pere Marquette Harbor, Mich. (see Luddington)	279			2184	
Petaluma Creek, Cal., improvement of	323			2446	
Peter's Neck Bay, N. Y., examination and survey of	55	637			
Petit Jean River, Ark., improvement of	206		1529		
Pigeon River, Mich., examination of	286			2207	
Pinepog River, Mich., examination of	294			2274	
Plattsburgh Harbor, N. Y., improvement of	314			2405	
Plymouth Harbor, Mass., improvement of	30	525			
Pocomoke River, Md., improvement of	96	847			
Pond River, Ky., examination of	249			1901	
Port Chester Harbor, N. Y., improvement of	51	620			
Port Clinton Harbor, Ohio, improvement of	297			2299	
Portage Lake, Mich., harbor lines in	257			1971	
Port Jefferson Harbor, L. I., N. Y., improvement of	34	632			
Portage Lake Canal, Mich., report on value of	257			1974	
Portland Harbor, Me., improvement of	17	448			
Portland Harbor, Me., channel in Back Cove, improvement of	18	451			
Portland, Oregon, Bridge, Willamette River, at	339				2668
Portage Lake, Mich., harbor of refuge at	278			2180	
Portsmouth Harbor, N. H., improvement of	20	463			
Port-warden's line at Philadelphia	85	820			
Potomac River, improvement of, at Washington, D. C	102	884			
Port Washington Harbor, Wis., improvement of	265			2050	
Providence River, R. I., Green Jacket Shoals, removal of	38	553			
Providence River, R. I., improvement of	37	550			
Provincetown Harbor, Mass., improvement of	30	528			
Public Buildings and Grounds, District of Columbia	336				2569
Pultneyville Harbor, N. Y., improvement of	309			2374	
Punta Rassa Harbor, Fla., examination and survey of	162				
R.					
Raccoon River, N. J., improvement of	83	810			
Racine Harbor, Wis., improvement of	268			2069	
Rahway River, N. J., improvement of	70	769			
Rancocas River, N. J., improvement of	82	807			
Rappahannock River, Va., improvement of	108	935			
Raritan Bay, N. J., improvement of	66	749			

Subject.	Page.			
	Part I.	Part II.	Part III.	Part IV.
Raritan River, N. J., improvement of	71 771			
Reconnaissances and explorations	344			
Redwood Harbor, Cal., improvement of	318		2424	
Red Lake River, Minn., from Grand Forks to Red Lake, examination of	229	1724		
Red River, Ark., lakes connecting with, between Shreveport and Fulton, Ark., examination of	203	1490		
Red River, La. and Ark., improvement of	193	1440		
Red River, Ark., improvement of above Fulton	203	1502		
Red River of the North, Minn., from Moorhead to Fergus Falls, examination and survey of	230	1733		
Red River of the North, construction of dam at Goose Rapids	229	1721		
Red River of the North, improvement of	228	1712		
Reedy Island, Delaware River, ice harbor at	80 804			
Reservoirs at headwaters of Mississippi River, construction of	224	1606		
River and harbor improvements	13			
Roanoke River, N. C., improvement of	112 955			
Roanoke River, Va., from Clarksville, Va., to Eaton Falls, N. C., examination of	114 960			
Rock Island Rapids, Mississippi River, improvement at	217	1607		
Rockland Harbor, Me., improvement of	17 446			
Rockport Harbor, Me., examination and survey of	22			
Rocky River, Ohio, improvement of mouth of	300		2315	
Romerly Marsh, Ga., improvement of	148	1174		
Rondout Harbor, N. Y., improvement of	57 663			
Rouge River, Mich., from Detroit River to bridge Saint Louis and Wabash Railroad, examination of	294		2275	
Rush Island Bend, Ill., Mississippi River at, examination and survey of	215			
Rouse's Point, Lake Champlain, breakwater at	313		2397	

S.

Subject.	Part I.	Part II.	Part III.	Part IV.
Sabine Pass, Tex., improvement of	187	1385		
Sabine River, Tex., improvement of	186	1383		
Sackett's Harbor, N. Y., improvement of	312		2391	
Sacramento and Feather rivers, Cal., improvement of	332		2441	
Saco River, Me., improvement of	18, 453, 455			
Saginaw River, Mich., improvement of	289		2250	
Saint Anthony, preservation of Falls of	223	1660		
Saint Augustine Creek, Ga., improvement of	148	1174		
Saint Augustine, Fla., survey of, for deep-sea channel on outer bar	162			
Saint Clair Flats Canal, Mich	291		2262	
Saint Clair Flats Canal, operating and care of	292		2264	
Saint Clair River, Mich., bar opposite Saint Clair City, examination of	294		2270	
Saint Croix River, Me., from bridge at Calais to Breakwater Ledge, examination of	22 477			
Saint Croix River., Wis., improvement of	227	1706		
Saint Francis River, from Greenville, Mo., to Arkansas State line, examination of	210	1549		
Saint Francis River, Ark., improvement of	209	1539		
Saint George's River, Me., from Warren to Thomaston, examination and survey of	21 473			
Saint Jones River, Del., improvement of	89 831			
Saint John's River and Fernandina, Fla., deepening inside passage between	153	1199		
Saint John's River, Fla., improvement of upper	156	1219		
Saint John's River, Me., examination and survey of Big Rapids	21 471			
Saint John's River, Fla., improvement of bar at mouth of	154	1207		
Saint Jerome's Creek, Md., improvement of	108 983			
Saint Joseph's Harbor, Mich., improvement of	284		2200	
Saint Mary's Falls Canal, operating and care of	287		2227	
Saint Mary's Falls Canal, Mich., construction of	280		2214	
Saint Mary's Falls Canal, construction of dry-dock at	287		2238	
Salem River, N. J., improvement of	84 811			
Salem, Oregon, Bridge, Willamette River at	339			2662
Salkiehatchie River, S. C., improvement of	144	1146		
Saline River, Ark., examination of	210	1546		
Saline River, Ark., improvement of	204	1505		
Salt River, Ky., examination of	249			
San Diego Harbor, Cal., survey of	320			
San Francisco Harbor and interior bays, survey of	318		2426	
San Diego Harbor, Cal., improvement of	320		2431	
Sand Beach, Lake Huron, Mich., harbor of refuge at	290		2256	
Sandusky City Harbor, Ohio, improvement of	297		2302	
Sandusky River, Ohio, improvement of	298		2305	
Sandusky Harbor, Ohio, straight channel from Cedar Point to east end of existing channel, examination and survey of	303		2336	

SUBJECT.	Page.				
	Part I.		Part II.	Part III.	Part IV.
Sandy Bay, Cape Ann, Mass., harbor of refuge at	24	497			
Sandy River, Louisa Fork of, Va., examination of	249		1902		
San Joaquin River, Cal., improvement of	321			2437	
San Luis Obispo, Cal., survey of harbor at	320			2438	
San Pedro Bay, Cal., near entrance to Wilmington Harbor, for an outer harbor, examination of	320				
Saugerties Harbor, N. Y., improvement of	57	660			
Santee River, S. C., improvement of	136		1081		
Saugatuck Harbor, Mich., improvement of	283			2196	
Savannah Harbor and River, Ga., improvement of	145		1150		
Savannah River, Ga., from cross-tides above Savannah to the bar, examination and survey of	154				
Savannah River, Ga., improvement of, above Augusta	148		1172		
Savannah River, Ga., improvement of, below Augusta	146		1165		
School of Application at Willets Point	12	415			
Schuylkill River, Pa., improvement of	78	800			
Scituate Harbor, Mass, improvement of	29	522			
Sea-coast and lake frontier defenses	4				
Sheboygan Harbor, Wis., improvement of	265			2047	
Sheepshead Bay. N. Y., improvement of	64	734			
Shenandoah River, Va. and W. Va., improvement of	105	925			
Shreveport, La., lakes connecting with Red River between Fulton, Ark., and, examination of	203		1490		
Shreveport, La., bridge over Red River at	339				2673
Shrewsbury River, N. J., improvement of	74	778			
Skagit River, Wash., improvement of	329			2490	
Smith's River, Cal., examination of mouth of	324			2450	
Snohomish River, Wash., improvement of	329			2490	
Snake River, Wash., improvement of	332			2520	
Snoqualmie River, Wash., improvement of	329			2490	
Sodus Harbor, N. Y., Great, improvement of	309			2376	
Sodus Harbor, N. Y., Little, improvement of	310			2379	
South Haven Harbor, Mich., improvement of	283			2198	
South Forked Deer River, Tenn., improvement of	202		1482		
South River, N. J., improvement of	72	778			
South Pass, Mississippi River, inspection of, improvement at	178		1345		
Southport Harbor, Conn., improvement of	50	615			
Spring Creek, N. Y., examination of	317				
Staten Island, N. Y., improvement of New Jersey Channel	65	743			
Steilaquamish River, Wash., improvement of	329			2490	
Staunton River, Va., improvement of	111 112	950 951			
Stamford Harbor, Conn., improvement of	51	618			
Stonington Harbor, Conn., improvement of	41	562			
Steel's Bayou, Miss., improvement of	200		1476		
Sturgeon Bay Canal, Wis., harbor of refuge at	262			2014	
Stockholm, Wis., harbor of refuge at	223		1658		
Sturgeon Bay Canal, Wis., report on acquisition of	262			2017	
Suislaw River and Bar, Oregon, examination of	330			2493	
Superier Bay, Wis., improvemant of harbor at	254			1945	
Sumpawanns Inlet, N. Y., improvement of	65	740			
Surveys and examinations for improvement of rivers and harbors, estimates for	333				
Susquehanna River, near Havre de Grace, Md., improvement of	92	836			
Suwanee River, Fla., improvement of	161		1253		
Swanton Harbor, Vt., improvement of	314			2399	
T.					
Tallahatchie River, Miss., improvement of	200		1474		
Tallapoosa River, Ala., improvement of	169		1285		
Tampa Bay, Fla., improvement of	159		1243		
Tampa Bay, Fla., resurvey of, and Hillsborough River up to Tampa	162		1257		
Tangipahoa River, improvement of	180		1361		
Tar River, N. C., improvement of	123		1010		
Taunton River, Mass., examination and survey of	43				
Taunton River, Mass., improvement of	35	544			
Tchefuncta River, La., improvement of	179		1358		
Tchula Lake, Miss., improvement of	199		1471		
Teche Bayou, La., improvement of	183		1370		
Teche Bayou, La., connection with Grand Lake at Charenton	184		1374		
Tennessee River, above Chattanooga, improvement of	230			1737	
Terrebonne Bayou, La., improvement of	182		1367		
Tennessee River, below Chattanooga, improvement of	230			1739	
Tensas River, La., improvement of	197		1463		
Thames River, Conn., improvement of	43	562			
Thoroughfare back from Cape May, N. J., to Atlantic City, examination and survey of	86				
Thunder Bay Harbor, Mich., improvement of	289			2249	

SUBJECT.	Page.			
	Part I.	Part II.	Part III.	Part IV.
Tickfaw River, La., improvement of	181	1362		
Tidewater River, Ky., improvement of	248		1895	
Ticonderoga River, N. Y., improvement of	316		2411	
Tillamook Bay and Bar, Oregon, examination of	330			
Toledo Harbor, Ohio, improvement of	295		2282	
Toledo Harbor, Ohio, straight channel, improvement of	296		2291, 2285	
Tombigbee River, Ala., improvement of	173 174	1324		
Tombigbee River, Miss., examination for continuous navigation from Vienna, Ala., to Walker's Bridge	178			
Tonawanda Harbor, N. Y., and Niagara River, from Black Rock for 16-foot channel, examination of	308			
Totusky River, Va., improvement of	109 938			
Torch Lake Channel, Lake Superior, examination of	266		2053	
Torpedo defense and experiments	8 417			
Trent River, N. C., improvement of	125	1016		
Trinity River, Tex., improvement of	189	1421		
Two Rivers Harbor, Wis., improvement of	263		2043	
U.				
Umpqua River, Oregon, etc., examination of	330		2499	
Umpqua River, Oregon, improvement of	326		2463	
Upper Columbia and Snake Rivers, Oregon and Wash., improvement of	332		2520	
Upper Mississippi River, improvement of	224	1664		
Upper Willamette River, Oregon, improvement of	331		2517	
Urbana Creek, Va., improvement of	109 939			
Upper Thoroughfare, between Deil's Island and mainland	96 846			
V.				
Vermillion Harbor, Ohio, improvement of	299		2310	
Vineyard Haven Harbor, Mass., examination and survey of	43 572			
Volusia Bar, Fla., improvement of	155	1216		
W.				
Wabash River, Ind., improvement of	246		1864	
Waccamaw River, S. C., improvement of	134	1065		
Wachita and Black Rivers, Ark. and La., improvement of	195	1455		
Waddington Harbor, N. Y., examination and survey of	317		2414	
Wakulla River, Fla., from its mouth to Wakulla Springs, examination and survey of	162	1260		
Wapoo Cut, S. C., improvement of	141	1138		
Wareham Harbor, Mass., improvement of	84 540			
Warren River, R. I., improvement of	86 547			
Warrior River, Ala., improvement of	172	1322		
Washington and Georgetown harbors, D. C., improvement of	101 883			
Washington Aqueduct, D. C	833			2527
Washington City water-supply, increase of	834			2535
Water levels, northern and northwestern lakes	343		2417	
Wateree River, S. C., improvement of	137	1069		
Water-gauges on Columbia River	329		2491	
Water-gauges on Mississippi River and tributaries	202	1485		
Waukegan Harbor, Ill., improvement of	269		2074	
Wellfleet Harbor, Mass., examination and survey of	31			
Westport Harbor, Mass., improvement of	35 543			
White River, Ark., improvement of	207	1534		
White River Harbor, Mich., improvement of	280		2187	
White River, Ind., improvement of	247		1871	
Wicomico River, Md., improvement of	95 844			
Willamette River, Lower, Oregon, improvement of	331		2507	
Willamette River, Upper, Oregon, improvement of	331		2517	
Willet's Point, post at	12 413			
Wilmington, Cal., construction of breakwater at	319		2429	
Wilmington Harbor, Del., improvement of	87 827			
Wilson Harbor, N. Y., improvement of	306		2366	
Winthrop Harbor, Mass., examination and survey of	31			
Winyaw Bay, S. C., improvement of	136	1078		
Wisconsin and Fox Rivers, improvement of	270		2077	
Withlacoochee River, Fla., improvement of	160	1248		
Wisconsin River, report on survey for improvement of	270		2094	
Woodbridge Creek, N. J., improvement of	71 770			
Woodbury Creek, N. J., improvement of	82 808			
Wood River, Oregon, examination of	330			
Wood's Holl Harbor, Mass., improvement of	33 537			
Wreck on San Francisco Bar, removal of	319		2,426	
Wrecks in Connecticut River, removal of	55 536			
Wrecks in Delaware Bay and River, removal of	85 813			
Wreck near Cape Henlopen, removal of	85 814			

SUBJECT.	Page. Part I.	Part II.	Part III.	Part IV.
Wreck in Broadkiln River, Del., removal of	96 847			
Wreck near Cove Point, Chesapeake Bay, removal of	101 879			
Wrecks in Patapsco River, Del., removal of	101 880			
Wreck in Pamlico River, N. C., removal of	123	990		
Wreck in Cape Fear River, N. C., removal of	139	1,097		
Wreck in Beaufort Harbor, N. C., removal of	139	1,098		
Wreck in Harbor of Tampa, Fla., removal of	162	1,256		
Wrecks in Bayou Teche, removal of	188	1,392		
Y.				
Yadkin River. N. C., examination of	139			
Yaquina Bay, Oregon, improvement of entrance to	326		2465	
Yadkin River, N. C., improvement of	133	1061		
Yalabusha River, Miss., improvement of	199	1473		
Yazoo River, Miss., improvement of	198	1467		
Yellowstone National Park, construction roads and bridges in	342			3133
Yellowstone River, Mont. and Dak., improvement of	216	1601		
York River, Va., improvement of	110 944			
York Harbor, Me., improvement of	19 462			

O

Stanford University Libraries
3 6105 009 855 367

Stanford University Libraries
3 6105 009 855 367